THE NATION'S WATER RESOURCES 1975-2000

Volume 4: Great Basin Region

Second National Water Assessment by the U.S. Water Resources Council

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**Second National
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Foreword

The Water Resources Planning Act of 1965 (Public Law 89-80) directs the U.S. Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. In 1968, the Water Resources Council reported the results of its initial assessment. The Second National Water Assessment, a decade later, provides a comprehensive nationally consistent data base for the water resources of the United States. The results of the Second National Water Assessment were obtained by extensive coordination and collaboration in three phases.

Phase I: Nationwide Analysis

The Council member agencies researched, analyzed, and prepared estimates of current and projected water requirements and problems and the implications of the estimates for the future.

Phase II: Specific Problem Analysis

Regional sponsors, one for each of the 21 water resources regions, surveyed and analyzed State and regional viewpoints about (1) current and future water problems, (2) conflicts that may arise in meeting State and regional objectives, and (3) problems and conflicts needing resolution.

Phase III: National Problem Analysis

The Council conducted this final phase in three steps: (1) An evaluation of phases I and II, (2) an analysis that identified and evaluated the Nation's most serious water resources problems, and (3) the preparation of a final report entitled "The Nation's Water Resources--1975-2000."

The final report of the Second National Water Assessment consists of four separate volumes as described below. These volumes can assist Federal, State, local, and other program managers, the Administration, and the Congress in establishing and implementing water resources policies and programs.

Volume 1, Summary, gives an overview of the Nation's water supply, water use, and critical water problems for "1975," 1985, and 2000 and summarizes significant concerns.

Volume 2, Water Quantity, Quality, and Related Land Considerations, consists of one publication with five parts:

Part I, "Introduction," outlines the origin of the Second National Water Assessment, states its purpose and scope, explains the numerous documents that are part of the assessment, and identifies the individuals and agencies that contributed to the assessment.

II, "Water-Management Problem Profiles," identifies ten general water problem issues and their implications and potential consequences.

Part III, "Water Uses," focuses on the national perspectives regarding existing ("1975") and projected (1985 and 2000) requirements for water to meet offstream, instream, and flow-management needs. State-regional and Federal perspectives are compared.

Part IV, "Water Supply and Water Quality Considerations," analyzes the adequacy of fresh-water supplies (ground and surface) to meet existing and future requirements. It contains a national water budget; quantifies surface- and ground-water supplies, reservoir storage, and transfers of water within and between subregions; describes regional requirements and compares them to supplies; evaluates water quality conditions; and discusses the legal and institutional aspects of water allocation.

Part V, "Synopses of the Water Resources Regions," covers existing conditions and future requirements for each of the 21 water resources regions. Within each regional synopsis is a discussion of functional and location-specific water-related problems; regional recommendations regarding planning, research, data, and institutional aspects of solving regional water-related problems; a problem-issue matrix; and a comparative-analysis table.

Volume 3, Analytical Data, describes the methods and procedures used to collect, analyze, and describe the data used in the assessment. National summary data are included with explanatory notes. Volume 3 is supplemented by five separately published appendixes that contain data for the regions and subregions:

Appendix I, Social, Economic, and Environmental Data, contains the socioeconomic baseline ("1975") and growth projections (1985 and 2000) on which the water-supply and water-use projections are based. This appendix presents two sets of data. One set, the National Future, represents the Federal viewpoint; the other set, the State-Regional Future, represents the regional sponsor and/or State viewpoint.

Appendix II, Annual Water Supply and Use Analysis, contains baseline water-supply data and baseline and projected water withdrawal and water-consumption data used for the assessment. Also included are a water adequacy analysis, a natural flow analysis, and a critical-month analysis.

Appendix III, Monthly Water Supply and Use Analysis, contains monthly details of the water-supply, water-withdawal, and water-consumption data contained in Appendix II and includes an analysis of monthly water adequacy.

Appendix IV, Dry-Year Conditions Water Supply and Use Analysis, contains both annual and monthly baseline and projected water-withdrawal and water-consumption data for dry conditions. Also, a dry conditions water-adequacy analysis is included.

Appendix V, Streamflow Conditions, contains detailed background information on the derivation of the baseline streamflow information. A description of streamflow gages used, correction factors applied, periods of record, and extreme flows of record, are given for each subregion. Also included is the State-Regional Future estimate of average streamflow conditions.

Volume 4, Water Resources Regional Reports, consists of separately published reports for each of the 21 regions. Synopses of these reports are given in Volume 2, Part V.

For compiling and analyzing water resources data, the Nation has been divided into 21 major water resources regions and further subdivided into 106 subregions. Eighteen of the regions are within the conterminous United States; the other three are Alaska, Hawaii, and the Caribbean area.

The 21 water resources regions are hydrologic areas that have either the drainage area of a major river, such as the Missouri Region, or the combined drainage areas of a series of rivers, such as the South Atlantic-Gulf Region, which includes a number of southeastern States that have rivers draining directly into the Atlantic Ocean and the Gulf of Mexico.

The 106 subregions, which are smaller drainage areas, were used exclusively in the Second National Water Assessment as basic data-collection units. Subregion data point up problems that are primarily basinwide in nature. Data aggregated from the subregions portray both regional and national conditions, and also show the wide contrasts in both regional and national water sources and uses.

The Second National Water Assessment and its data base constitute a major step in the identification and definition of water resources problems by the many State, regional, and Federal institutions involved. However, much of the information in this assessment is general and broad in scope; thus, its application should be viewed in that context, particularly in the area of water quality. Further, the information reflects areas of deficiencies in availability and reliability of data. For these reasons, State, regional, and Federal planners should view the information as indicative, and not the only source to be considered. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered.

In a national study it is difficult to reflect completely the regional variations within the national aggregation. For example, several regional reviewers did not agree with the national projections made for their regions. These disagreements can be largely attributed either to different assumptions by the regional reviewers or to lack of representation of the national data at the regional level. Therefore, any regional or State resources-management planning effort should consider the State-regional reports developed during phase II and summarized in Volume 4 as well as the nationally consistent data base and the other information presented in this assessment.

Additional years of information and experience show that considerable change has occurred since the first assessment was prepared in 1968. The population has not grown at the rate anticipated, and the projections of future water requirements for this second assessment are considerably lower than those made for the first assessment. Also, greater awareness of environmental values, water quality, ground-water overdraft, limitations of available water supplies, and energy concerns are having a dramatic effect on water-resources management. Conservation, reuse, recycling, and weather modification are considerations toward making better use of, or expanding, available supplies.

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Illustrations

Physiography

Description

The Great Basin lies between the Wasatch Range in Utah and the Sierra Nevada Range in California and Nevada. From north to south, it extends between the Malheur closed basin in Oregon to the Mojave Desert in California. For purposes of this assessment, those parts of the basin in Oregon, California, and Wyoming are excluded. The region's area as defined for the assessment encompasses about 139,345 square miles[1] including 91,800 square miles in Nevada (about two-thirds of the State), 43,800 square miles in Utah, and 1,400 square miles in Idaho. Figure 16-1 shows the boundaries of the region. Figure 16-2 shows present land use.

Geographically, the Great Basin is characterized by a series of desert valleys separated by north-south oriented mountain ranges. This parallelism of mountain chains is a physiographic feature peculiar to the Great Basin. Much of the region was once covered by prehistoric Lake Bonneville and Lake Lahontan. Ancient shorelines, beach features, and lake remnants remain as prominent features.

Streamflow in the region is closely related to precipitation and elevation. Several minor rivers originate in the higher mountains which are located mainly on the east and west edges of the region. All of the rivers and streams in the region terminate in closed basins, some of which contain permanent lakes. The largest of these terminal lakes are Pyramid and Walker Lakes in Nevada and the Great Salt Lake in Utah. Minor streams range from perennial to intermittent. Some of these are tributary to permanent rivers while others flow only after major storms.

The vegetation of the region varies with precipitation. Salt desert and northern desert shrubs each occupy nearly one-third of the land area. The principal vegetation type in the mountain areas, especially in the southern portions, is pinon-juniper woodland.

Geology

The numerous mountain ranges in the region are composed of rocks folded and faulted in a complex manner. Alluvium underlies the intervening valleys. Older rocks, about the same age as those forming the mountains, underlie the valleys at depths of several hundred to several thousand feet. Faults adjacent to the mountain fronts are still active and the mountain blocks continue to rise in relation to the valleys. Agents of erosion are wearing away the mountains, and the products are being deposited in the valleys.

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[1]This is the sum of the areas of counties used to approximate the hydrologic area of the region. Land use and other socioeconomic data are related to this area. The drainage area within the hydrologic boundary is 142,070 square miles.

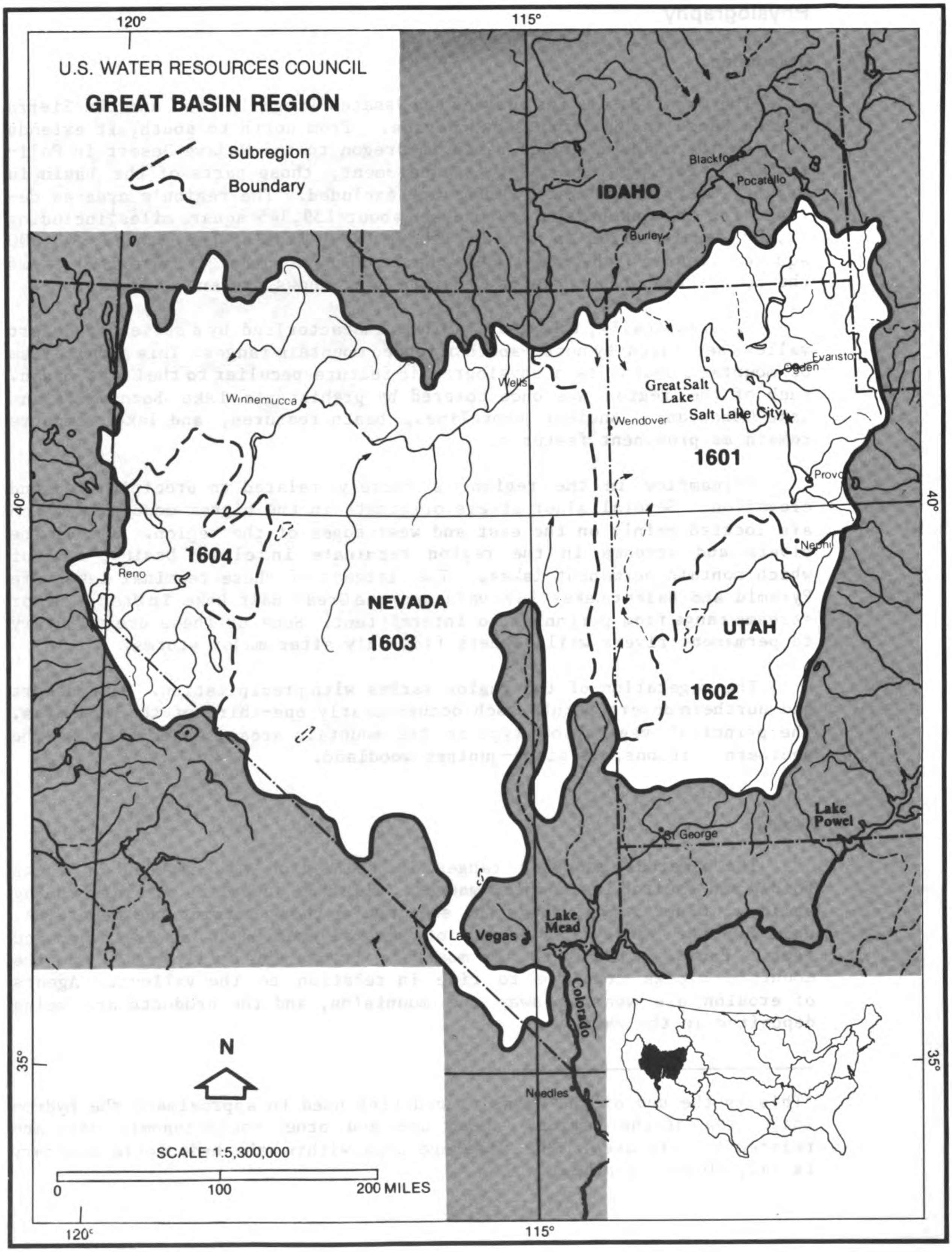

Figure 16-1. Region Map

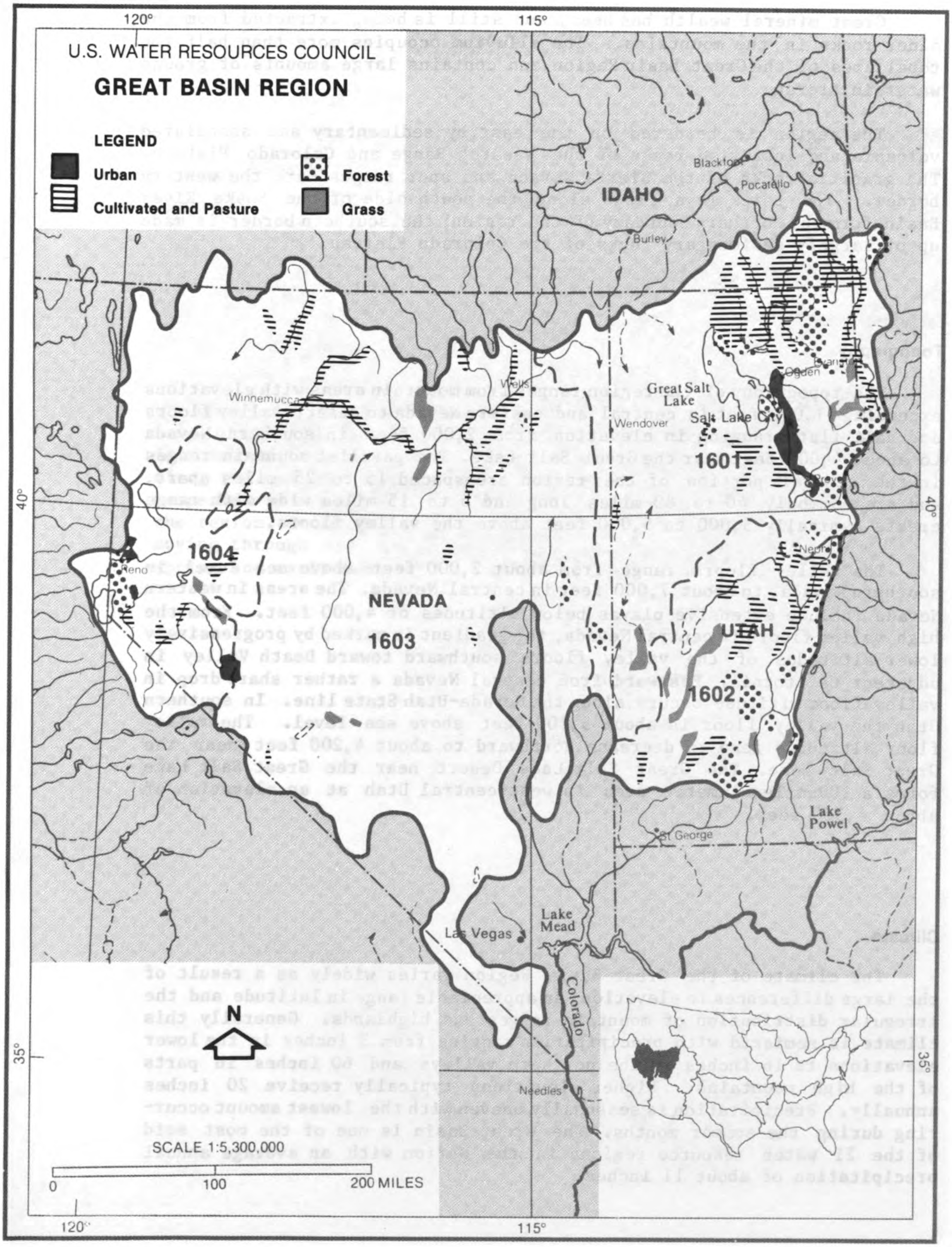

Figure 16-2. Present Land Use

Great mineral wealth has been, and still is being extracted from the older rocks in the mountains. The alluvium occupies more than half the total area of the Great Basin Region and contains large amounts of ground water in storage.

The region is bordered on the east by sedimentary and associated volcanic and intrusive rocks of the Wasatch Range and Colorado Plateau. The granitic rocks of the Sierra Nevada and spur ranges mark the western border. The thick lava flows along the south side of the Snake River Basin form the northern boundary of the region; the southern border is made up of largely sedimentary rocks of the Colorado Plateau.

Topography

The topography of the region ranges from mountain areas with elevations exceeding 11,000 feet in central and eastern Nevada to desert valley floors and salt flats ranging in elevation from 2,000 feet in southern Nevada to about 4,000 feet near the Great Salt Lake. The parallel mountain ranges in the central portion of the region are spaced 15 to 25 miles apart, and are commonly 40 to 80 miles long and 5 to 15 miles wide with range crests typically 3,000 to 5,000 feet above the valley floors.

The valley floors range from about 2,000 feet above sea level in southern Nevada, to about 7,000 feet in central Nevada. The areas in western Nevada include extensive playas below altitudes of 4,000 feet. From the high valley floors in central Nevada, the gradient is marked by progressively lower altitudes of the valley floors southward toward Death Valley in adjacent California. Eastward from central Nevada a rather sharp drop in valley-floor altitude occurs along the Nevada-Utah State line. In southern Utah the valley floor is about 5,100 feet above sea level. The valley floor altitudes tend to decrease northward to about 4,200 feet near the Great Salt Lake. The Great Salt Lake Desert near the Great Salt Lake forms a 100-mile diameter area in west-central Utah at an elevation of about 4,300 feet.

Climate

The climate of the Great Basin Region varies widely as a result of the large differences in elevation, an appreciable range in latitude and the irregular distribution of mountain ranges and highlands. Generally this climate is semiarid with precipitation ranging from 3 inches in the lower elevations to 16 inches in the northern valleys and 60 inches in parts of the high mountains. Higher elevations typically receive 20 inches annually. Precipitation is seasonally uneven with the lowest amount occurring during the summer months. The Great Basin is one of the most arid of the 21 water resource regions in the Nation with an average annual precipitation of about 11 inches.

Temperatures in the region are like those of other inland areas in that they reach extreme highs and lows. One of the outstanding features of the temperatures in the Great Basin Region is the wide range between the daily maximum and minimum. Average daily ranges, over most of the lower valleys, are in excess of 30°F. Ranges in excess of 50°F are not at all uncommon in some of the valleys of western Nevada. Average temperatures range from about 60°F in the extreme southern portion down to 30°F to 35°F in some of the high northern valleys. In the agricultural areas the frost-free season varies between 70 and 200 days per year.

The relative humidity is low during most of the year, averaging between 30 to 40 percent in the northern and central sections of the region, but dropping to 20 percent in the extreme south. Minimum relative humidities, as low as 5 percent, occasionally occur during the dry summer months in the extreme southern part of the region.

Wind speeds are usually light to moderate, ranging normally below 20 miles per hour. However, strong winds attaining damaging velocities occur occasionally in local areas. The strongest winds are found either near the east slope of the sierra or in the vicinity of the canyon mouths along the western Wasatch Mountains. Isolated thunderstorms may be accompanied by damaging winds and a few tornadoes have been observed in the region. Occasional dust storms result from low pressure disturbances moving through the dry desert areas. These are most prevalent during spring and early summer.

People and the Resources

An analysis of current and future activities is basic to any identification of water and related land resources in the Great Basin Region. The foundation for this analysis is the collection of estimates and projections of the regional population, economy, land use, water resources availability and use, and other related parameters. These and other estimates and projections were made for the Great Basin Region as explained elsewhere in the National Assessment report. These data for the region and subregions are referred to as the National Future (NF). Where projected into the future, these data are based on allocation to the region of a share of national production consistent with national projections. States and regional representatives independently provided alternative estimates, called the State-Regional Future (SRF). All information presented in this section is based on NF data unless specifically identified as SRF data. A comparison and discussion of the differences between NF and SRF data and implications of the variations are included at the end of this section.

Population

This region was the last large portion of the United States to be explored because of its difficult terrain and inhospitable climate. It was first entered in 1776, at its southern extremity by Father Francisco Garces and at its eastern extremity by Fathers Dominguez and Escalante through Spanish Fork Canyon. It was first successfully crossed by the American mountain man, Jedediah Smith, in 1827. Peter Skene Ogden and the Hudson's Bay fur trappers followed in 1828-1829. These men, as well as other early trappers and mountain men, notably Joseph Walker, had learned that the entire area between the Wasatch Range and the Sierra Nevada was a closed basin. However, the basin's existence as a geographical entity did not become generally known and accepted until John C. Fremont's 1843-1844 official expedition. Fremont's exploration of the region was completed early enough to benefit the great flow of westward migration. This emigrant tide began to gather force in 1846 and boomed with the onrush of the California goldseekers in 1849.

The first non-Indian settlements in the Great Basin Region began in a unique way. A mass migration of Mormon families led by Brigham Young brought about 2,000 people into the Salt Lake Valley in 1847. The migration continued and within ten years 50,000 people had settled in this area. Most of thse new arrivals settled near what is presently Salt Lake City. Families were soon dispatched to settle most of the cities and towns in the eastern part of the region. These cities and towns were laid out in an orderly rectangular pattern, usually at the mouths of canyons. Water was diverted from the streams to the adjacent lands for irrigation and production of food crops. The families lived within the towns and farmed the outlying areas. This type of settlement accomplished two main purposes, protection from Indians and enhancement of social and religious life. These early residents were soon joined by growing numbers of persons in the Nevada area of the region where mining grew rapidly.

The Great Basin Region population had expanded by 1975 to about 1.26 million persons, or an average of nine persons per square mile. However, population is distributed through the region very unevenly with the large majority located near either the eastern or western boundary. About 77 percent of the population lives in subregion 1601, which includes Salt Lake City and its suburban areas. Population in the region is projected to increase 38 percent by 2000 to 1.7 million, with most of the increase in subregion 1601. The greatest rate of growth, however, is expected to take place in subregion 1604, located in western Nevada and including the Reno-Sparks-Carson City area. The projection of further concentration of population in these areas reflects anticipation that the present movement of population from rural to urban residence will continue. Even in those rural areas of the region that lack sizable cities and are classified as rural, most of the population lives in small towns or villages.

Economy

Settlement and development in the eastern portion of the Great Basin differed radically from that of the western portion. Initial development in the eastern parts was based upon an agrarian economy, while that of the Nevada portion was based on a mining economy. Mining and lumbering did not become major factors contributing to the economy of the eastern part of the region until after the coming of the Union Pacific and Central Pacific railroads in 1869.

The Comstock, Esmeralda, Humboldt, and Reese River mining camps of central and western Nevada set the stage for rapid growth in the western part of the region from 1859 to 1890. At the time of the Comstock Lode discovery in 1859, agriculture in Nevada was confined to a few ranches along the pioneer trails. Mining discoveries triggered the import of cattle whose numbers mushroomed in Nevada from about 10,000 in 1860 to 211,000 in 1890.

Major mineral production in Utah began about 1869. Metals produced included gold, silver, lead, copper, and zinc. Large-scale copper production from low-grade porphyry ores at Bingham began about 1905. Expansion of coal and iron mining and the birth and development of Utah's steel industry at Geneva have taken place since the turn of the century.

After a period of decline from 1885 to 1900, Nevada's metal mining industry revived with the discovery of silver and gold lodes at Tonopah and Goldfield. During this first decade of the new century, the large copper mining and milling operations at Ruth, Ely[1], and McGill in central Nevada, and the operations at Weed Heights in western Nevada, began production.

[1]Copper production has ceased at Ely due to environmental restrictions and market conditions.

Nevada's large range livestock industry received its original impetus from the demands of the mining camps for beef. Cattle barons with immense land holdings ruled the State during the 1870's and 1880's. The range livestock business was severely crippled by the disastrous "White Winter" of 1889-1890. Following this, many of the large spreads were broken into smaller units. The trend for the past ten years has been toward larger holdings similar to, but still not as large as, the immense operations of the late nineteenth century.

Tourism, now a major enterprise in the Great Basin Region, had its start when trains full of easterners began rolling west over the railroads shortly after their completion in 1869. Later, the development of the automobile and the highway system accelerated travel and tourism in the basin. In 1914 the Nation's first transcontinental auto thoroughfare, the Lincoln Highway, was opened across the Great Basin connecting Salt Lake City, Ely, Carson City, and Reno. This was followed by many other highways, including the present Interstate 80, which now provide an extensive network covering the region. The ghost towns of the early mining days, as well as the vast open spaces themselves, provide an attraction for many. Also the etablishment of national parks and monuments with the development of all-season recreational facilities has provided a stimulus to greater tourist interest and accommodation.

Nevada tourism received further impetus in 1931 with the legalization of slot machines and table gambling games. The gaming industry has now grown to be the State's largest enterprise, with large casinos for both first class entertainment and gaming at Las Vegas, Reno, Lake Tahoe, and in many of the smaller towns.

The latest trend for the attraction of tourists to this region for recreation has been the development of ski slopes and other snow oriented sports in the high mountains on both the eastern and western edges of the Great Basin. This new attraction is converting these areas to year-round recreational areas, with the type of recreation available being governed by the seasons.

The arid climate of the Great Basin Region, the fairly short growing season, and large areas of mountainous lands have significantly influenced the types and extent of the area's economic development. Water has historically been and is expected to continue to be the limiting factor in agricultural development, particularly in those central areas away from the Wasatch Front and Sierra Nevada.

The 1975 total earnings for the region amounted to nearly $6 billion. Major earnings were in the "other" category as shown in Table 16-1 with about 81 percent of the total, far overshadowing the other individual categories. The "other" category includes gaming; wholesale and retail trade; government; services; transportation, communities, and public utilities; contract construction; and finance, insurance, and real estate. Shares of earnings for remaining categories were: agriculture (3 percent); manufacturing (13 percent); and mining (3 percent).

Table 16-1.--Great Basin Region earnings--1975, 1985, 2000
(million 1975 dollars)

Earnings sector	1975	1985	2000
Manufacturing	787	1,142	1,829
Agriculture	187	187	224
Mining	183	219	278
Other	4,834	7,589	13,792
Total	5,991	9,137	16,123

About 517,000 people were employed in the region in 1975; estimated per capita income varies considerably among the four subregions. Subregion 1604 has the highest per capita income ($7,000) followed by subregion 1603 ($6,429) and subregion 1601 ($5,364). The lowest per capita income ($4,676) is in subregion 1602. Per capita income for the region is about 9 percent below the national average.

Earnings are projected to increase from a total of $5,991 million in 1975 to about $16,123 million by 2000. The per capita income is projected to almost double by 2000 but still remain about 7 percent below the national average.

Natural Resources

The principal natural resources of the Great Basin include relatively large expanses of fertile lands on the valley floors, a variety of metallic and nonmetallic minerals, and over 12 million acres of forests. Because of its scarcity, water is not only a major resource but one which is crucial to the effective management and development of the land and mineral resources. The water resource is separately discussed in a later section.

In the Great Basin there are over 87 million acres of land of which about three-fourths are administered by the Federal Government. Most of the Federal lands are found in the arid and sparsely vegetated sections of the region. Private land generally is in the fertile valleys where water exists; however, a large amount of private land is associated with the railroad land grants which produced a checkerboard pattern of land ownership that stretches across the northern part of the region.

Soils in the region are highly variable. Clay loams predominate in the flat valley floors while mountain valley soils range from loamy sand to clay. On the alluvial fans and lake terraces the soils are commonly loam textured in the lower positions to sandy loam near the mountains. The soils of the mountain slopes throughout the region are extremely variable. They are commonly shallow over bedrock on the ridges and convex slopes. Soil textures range from loamy to clay.

Land uses in the Great Basin are varied. Estimates of the 1975 distribution of land use in the region are shown in Table 16-2. Over 73 percent of the total land area is cropland, pasture, or range. About

2 percent of the region's total land area is irrigated. The remainder of the regional land is either water surface (2 percent) or falls into the "other" use category (11 percent) which includes urban and industrial, military, transportation and utility, and designated recreation uses.

The most intensive land uses (irrigation and urban-industrial) are generally closely associated with water. Since most of the surface water supply originates along the eastern and western boundaries of the region, land use for irrigated cropland and urban and industrial areas is also similarly located. The vast interior areas are utilized primarily for grazing; however, significant withdrawals have been made for fish and wildlife areas and military use. Considerable multiple use of land takes place. For example, some irrigated cropland is used for grazing and some timber and grazing lands are used for recreation.

Mineral production, historically, has been one of the principal sources of new wealth in the Great Basin Region. Metals account for the large majority of total mineral production with smaller amounts of nonmetallic minerals and fuels being recovered. Copper accounted for over half the value of all mineral output; molybdenum, gold, iron ore, and sand and gravel ranked next in value of commodities produced. The region is also one of the leading areas in the United States in the production of lead, silver, mercury, barite, diatomite, magnesite, phospate rock, and beryllium. Lake brine is receiving increased attention as a source of mineral production.

Table 16-2.--Great Basin Region surface area and 1975 land use

Surface area or land use type	1,000 acres	Percentage of total surface area
Surface area		
Total	89,181	100.0
Water	1,760	2.0
Land	87,421	98.0
Land use		
Cropland	2,623	3.0
Pasture and range	61,269	68.7
Forest and woodland	12,251	13.7
Other agriculture	267	0.3
Urban	378	0.4
Other	10,633	11.9

The major copper-producing districts have been Ely, Yerington, and Battle Mountain in Nevada; and Bingham, Tintic, and Park City in Utah.[1] These districts also have produced large quantities of gold, silver, lead, zinc, and molybdenum. Most of Nevada's copper production has come from the

[1] Copper production has ceased at Ely and Yerington due to environmental restrictions and market conditions.

Ely district where large disseminated porphyry bodies are mined by open-pit methods. The ore is processed at McGill, the only copper smelter in Nevada. The Bingham district in Utah includes the largest copper producing mine in the United States; copper ores disseminated in porphyry have been mined there by open-pit methods since 1907. In the Tintic and Park City districts, copper occurs as a replacement and is recovered from silver-gold-lead and silver-lead-zinc ores. Gold recovered as a by-product, primarily from the copper ores of the Bingham district in Utah and the Ely district in Nevada, accounts for most of the gold now produced in the region. Silver is recovered as a by-product or co-product at some deposits. Iron ore deposits are widely scattered throughout the region, but only a few are productive. The only known major deposits and reserves in Utah are in the Iron Springs district in south-central Iron County. About 75 percent of Utah's iron ore mined is used for the Geneva Steel plant near Provo; the remainder is shipped out, chiefly to Pueblo, Colorado. Utilization of Nevada's iron ore at western steel centers has been small because adequate sources have been available closer to the plants. Most of the iron ore produced in Nevada has been shipped to Japan.

Nearly all of the region's counties contain commercial deposits of sand and gravel. Usually the sand and gravel industry is centered around the larger metropolitan areas such as Reno, Nevada, and Salt Lake City, Utah. The region is notably lacking in mineral fuels. Although Utah contains large coal fields, most of them lie outside the region east of the Wasatch Plateau. In the region, most of the coal is mined from the western parts of the larger coal fields in Sevier, Sanpete, Summit, and Iron Counties. The coal ranges from sub-bituminous to bituminous and is low to moderate in ash and sulfur content.

Agriculture

Agriculture has historically been an important part of the regional economy. It presently uses 64.1 million acres, including 61.3 million acres of range and 2.6 million acres of cropland. This does not include forestland also used for grazing. In 1975, about one-half of the cropland plus 0.4 million acres of pasture and hayland were irrigated. Hay and pasture account for 80 percent of the irrigated acreage with grains accounting for most of the rest. Cropland is projected to increase by 7 percent during the 1975-2000 period while irrigated acreage is projected to decrease by about this same percentage (Table 16-3).

Table 16-3.--Projected changes in cropland and irrigated farmland in the Great Basin Region--1975, 1985, 2000
(1,000 acres)

Land category	1975	1985	2000
Total cropland	2,623	2,834	2,800
Cropland harvested	1,781	2,194	2,119
Irrigated farmland	1,739	1,513	1,621

Irrigated cropland and pasture in the region generally occupy gently to moderately sloping areas of deep soils in the valleys. Many irrigated areas have been established on the alluvial fans of small streams emanating from the mountains. This gives rise to a scattered pattern of small farming areas throughout the region. However, on the major streams more extensive and adjacent irrigation projects have been developed. Dry cropland is essentially all in the eastern portion of the region where annual precipitation ranges from 12 to 20 inches and soil, climate, and other physical conditions are favorable. The dry farms are generally large and operations are highly mechanized.

Grazing lands constitute over two-thirds of the total land area of the region. Lands which are either too stony, too low in rainfall, lack irrigation water, or are located where the climate is unfavorable for cultivated crops, are used for grazing range. Rangelands provide about one-third of the annual feed requirements for all the livestock in the region. These lands are also used for other purposes in addition to livestock grazing, with various areas important for watersheds, recreation, timber, and big game production.

Energy

The amount of steam electric and conventional hydroelectric power generated in the region during 1975 was estimated at about 3,537 gWh. Conventional hydroelectric facilities produced about 454 gWh; fossil-fueled steam electric facilities produced about 3,083 gWh. About 6 percent of total steam electric generation used once-through cooling.

Projected electric generation for 2000 is 124,491 gWh. About 527 gWh are expected to be generated by five hydroelectric facilities located in subregion 1601 and about 92 percent or 114,500 gWh is projected to come from nuclear plants. The total number of projected steam electric plants in 2000 is ten, of which four are expected to use fossil fuels. Table 16-4 shows the 1975 and expected future distribution of electric power production between fossil, nuclear-fueled, and hydropower plants.

Table 16-4.--Great Basin Region electric power generation--1975, 1985, 2000 (gigawatt-hours)

Fuel source	1975	1985	2000
Fossil----------------------	3,083	9,764	9,464
Nuclear---------------------	0	14,460	114,500
Conventional hydropower-----	454	527	527
Total generation----------	3,537	24,751	124,491

Navigation

There is no commercial navigation in the Great Basin Region.

Environment

The Great Basin Region is rich in environmental resources. Elbow room, a place to move around in, and the happy prospect of getting off by one's self, can be found within relatively short distances from the region's population centers. Population density is among the lowest of all the country's regions, and even the populations projected for 2000 will not begin to tax the space resources of the region. In recent years, the true value of this magnificent space resource has begun to be recognized (Figure 16-3).

Outdoor recreational opportunities in the region enable a full gamut of activities including hunting, fishing, skiing, backpacking, camping, and others. The Reno-Lake Tahoe area is world famous for its winter sports, gambling casinos, and entertainment.

Most of the region's vast area is available for recreational purposes in combination with other uses. Recreational lands are generally located in the mountains along the eastern and western fringes of the region. The Sierra Nevada Range along the western border with its water areas near the eastern base of the mountains, as well as the Wasatch Mountains along the eastern border with its water areas on its western slopes, provide extensive recreational opportunities. The present development of snow-related sports has made them year-round recreational areas. Tourism is also developing in the interior as people are discovering the pleasures of the deserts and the excitement of exploring the ghost towns left from the mining days.

The water surface area available and suitable for recreation amounts to more than one million acres, including 0.7 million acres in the Great Salt Lake. Other prominent natural water bodies include Bear Lake, and part of Lake Tahoe in Nevada. Many of the reservoirs in the region are developed for water-based recreation. Fishing waters are located mainly in or near the Wasatch Range and the Sierra Nevada. A significant part of the total area of fishable waters is in manmade reservoirs. Fish species include whitefish, bass, perch, catfish, pike, and various types of salmon and trout. In many areas, the present supply exceeds the demand for man-days of angling.

The ability of wildlife habitat to produce harvestable supplies of some species of big game, upland game, and waterfowl attracts hunters from several regions. Much of the upland game hunting occurs on forest and range-lands.

Most of the upland game hunting opportunity occurs on cropland. Water-fowl habitat is generally concentrated in large marsh areas. These are the eastern shore of the Great Salt Lake in Utah, the terminal reaches of the Carson, Walker, and Humboldt Rivers, and the Ruby Lake area in Nevada. Large game animals include deer, antelope, bighorn sheep, elk, and mountain lion. Upland game are grouse, pheasant, partridge, quail, and Merriam's Turkey. Migratory game birds are swan, goose, duck, pigeon, and mourning doves. The region has several endangered species of fish and wildlife.

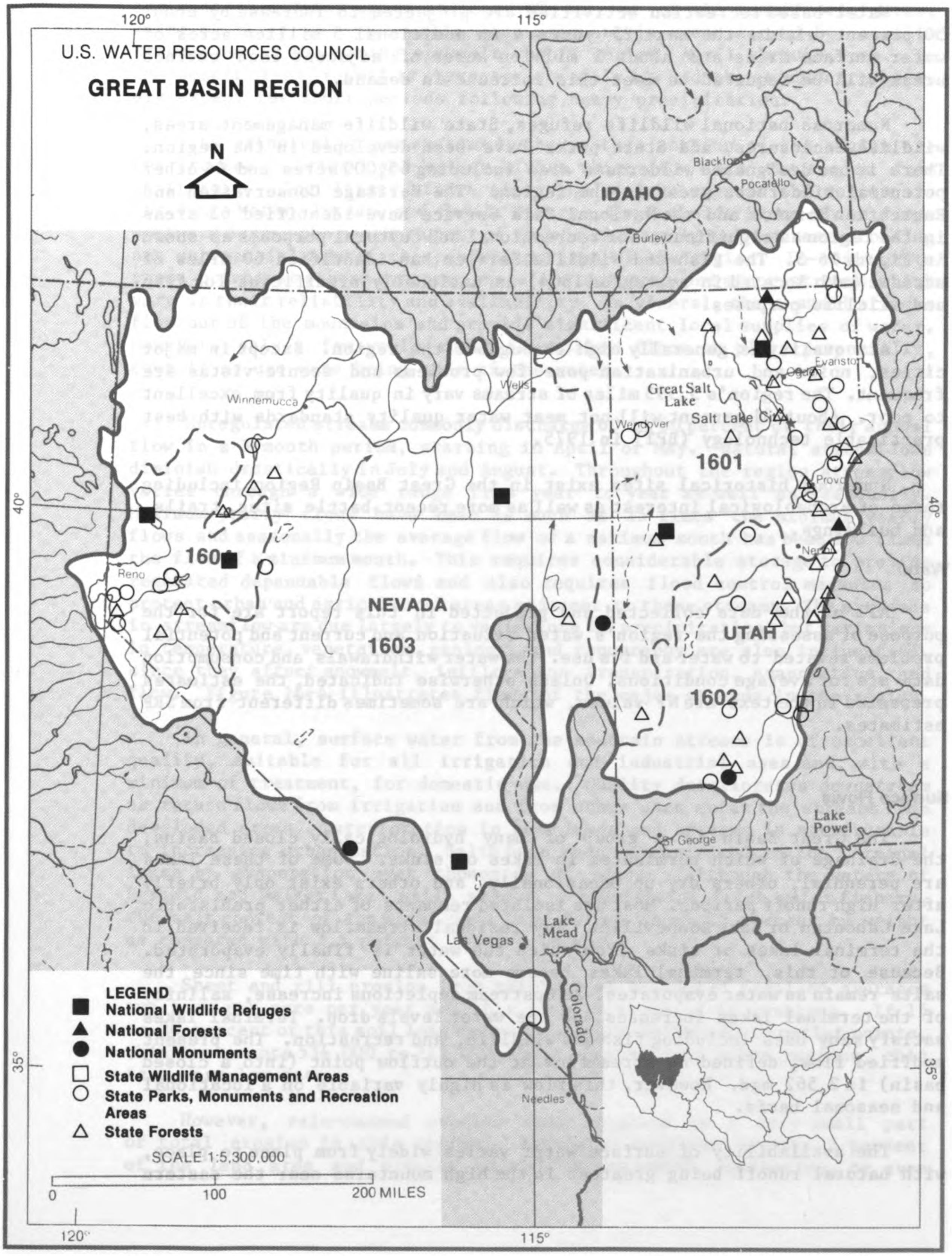

Figure 16-3. Environmental Resources

Water-based recreation activities are projected to increase by about 50 percent within the next 25 years. An additional 5 million acres of water surface areas and about 5 million acres of adjacent land surface areas will be required to meet this increase in demand.

Numerous national wildlife refuges, State wildlife management areas, wildlife enclosures, and State parks have been developed in the region. There is one designated wilderness area including 65,000 acres and 44 other potential wilderness areas in the region. The Heritage Conservation and Recreation Service and the National Park Service have identified 63 areas in the region as significant for recreational and cultural purposes as shown in Figure 16-3. The Fish and Wildlife Service has identified 60 miles of streams (all located in subregion 1604) as nationally significant for fish and wildlife purposes.

Air quality is generally high throughout the region. Except in major cities, noise and urbanization pose few problems and scenic vistas are frequent. The region's 5,595 miles of streams vary in quality from excellent to poor. About 31 percent will not meet water quality standards with best practicable technology (BPT) in 1975.

Numerous historical sites exist in the Great Basin Region including those of archeological interest as well as more recent battle sites, trails, and buildings.

Water

All of the data collected and projected in this report are for the purpose of assessing the region's water situation and current and potential problems related to water and its use. The water withdrawals and consumption data are for average conditions. Unless otherwise indicated, the estimates presented in the text are NF values, which are sometimes different from SRF estimates.

Surface Flows

The Great Basin is a group of many hydrologically closed basins, the drainage of which terminates in lakes or sinks. Some of these lakes are perennial, others dry up occasionally, and others exist only briefly after high runoff periods. Most are isolated remnants of either prehistoric Lake Lahontan or Lake Bonneville. Any residual streamflow is received in the terminal lakes or sinks from which the water is finally evaporated. Because of this, terminal lakes become more saline with time since the salts remain as water evaporates. As upstream depletions increase, salinity of the terminal lakes increases and the water levels drop. Terminal lakes satisfy many uses including fish and wildlife, and recreation. The present modified flow, defined as streamflow at the outflow point (into a closed basin) is 2,562 mgd. However, this flow is highly variable on a locational and seasonal basis.

The availability of surface water varies widely from place to place, with natural runoff being greatest in the high mountains near the eastern and western margins where at least 80 percent of the runoff originates. Water supplies have generally been adequate in areas served by mountain streams during the spring snowmelt runoff period, April through June. In the desert areas, runoff is characteristically low and the streams are often dry except for short periods following heavy precipitation.

The principal stream systems in the western portion of the region are the Truckee, Carson, and Walker Rivers which flow into the region from California. The larger rivers along the eastern edge of the region are the Bear, Weber, Jordan, and Sevier Rivers. The Humboldt River which flows westward across the northern part of Nevada is the only major stream crossing any substantial part of the central portion of the region. In addition to these principal stream systems, there are numerous and minor streams which vary in their reliability and availability. In general, these small streams flow out of the mountains and provide significant local supplies of water. However, only a few would reach the valley floor or playa perennially, even if no use were being made of the water.

Unregulated streams commonly discharge 60 to 80 percent of their annual flow in a 3-month period, starting in April or May. Natural streamflows diminish drastically in July and August. Throughout the region streamflow varies through a wide range from year to year as well as seasonally. Maximum yearly flows have been as much as 25 times the minimum yearly flows and seasonally the average flow of a maximum month has been 100 times the flow of a minimum month. This requires considerable storage to provide regulated dependable flows and also requires flood control measures to protect urban and agricultural areas adjacent to these streams. The extremes in streamflow are due largely to variations in precipitation, but variations in temperature, vegetation, geology, and topography are also influential, since they affect snowmelt, infiltration, transpiration, evaporation, and flow. Figure 16-4 illustrates flows of the major streams in the region.

In general, surface water from the mountain streams is of excellent quality, suitable for all irrigation and industrial uses and, with a minimum of treatment, for domestic use. Quality deteriorates downstream as return flows from irrigation and from other uses enter the streams from developed areas. Deterioration in some lakes and streams is attributable to increasing urbanization. Salts have been concentrated in the terminal lakes by evaporation over thousands of years. Although the waters of Pyramid and Walker Lakes still support a substantial fresh water fishery, the salt content of the Great Salt Lake is now about 25 percent by weight as compared with 3.5 percent for the oceans.

Sheet and rill erosion from rainfall on harvested cropland averages two tons per acre per year and this rate is expected to continue. If 15 to 20 percent of this soil loss becomes sediment delivered to outlet points, this represents 534,000 to 712,000 tons. Compared to other regions, this is a very low rate.

However, rain-caused erosion from cropland is a very small part of total erosion in this region. Harvested cropland is only 2 percent of the land area and erosion related to snowmelt, irrigation, or even

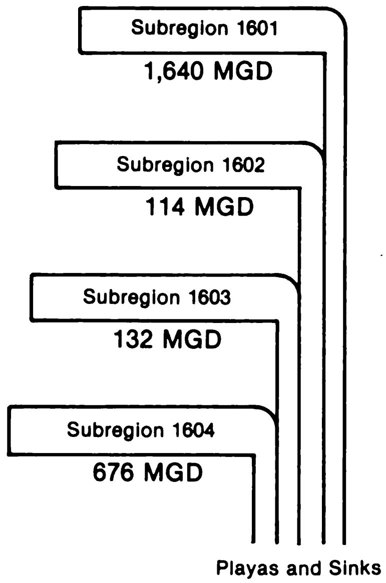

Figure 16-4. Streamflow

wind may exceed the rain-caused sheet and rill erosion. Erosion from rangeland and sparsely covered forest land exceeds erosion from cropland. Sediments from landslides, mudflows, gully, and streambank erosion probably equal or exceed the sediments from all of the sheet and rill erosion in the region. Part of the gully and streambank erosion is related to increased runoff caused by poor range conditions.

The estimated total annual sediment delivery from streams in the basin is about 16,765 acre feet or about 33 million tons. With potential land treatment this could be reduced to about 28 million tons per year.[1]

Excessive concentrations of nutrients exist in some streams in the region. The nutrients are derived mainly from municipal sewage treatment plant effluents, septic tank infiltration, and some undetermined contribution from irrigation. Total coliform counts in streams occasionally exceed acceptable standards for public water supplies. The effluent from food processing plants and municipal waste treatment plants is a major source of bacteriological pollution and is known to cause large increases of bacterial concentrations in a few streams. Residual Biochemical Oxygen Demand (BOD) generation is estimated at about 97 million pounds for 1973. About 70 percent of this amount is produced in subregion 1601. The amount of this discharged to water bodies is about 43 million pounds, most of which would come from municipal sources. With Best Available Technology (BAT), the amount discharged to water bodies could be reduced to about 20 million pounds per year for the region.

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[1]Erosion, Sediment and Related Salt Problems and Treatment Opportunities. USDA, SCS Special Projects Division, 1975.

Waste heat from power plants discharged to natural fresh water bodies is projected to increase from one trillion Btu's in 1975 to 202 trillion Btu's in 2000 (SRF Data). In addition, about 39 trillion Btu's are projected to be discharged into the Great Salt Lake in 2000. Waste heat discharged to natural water bodies from manufacturing activities is projected to decrease from about three trillion Btu's in 1975 to less than one trillion Btu's in 2000.

Floods occur from heavy snowmelt runoff or the summer cloudbursts which are characteristic of the area. They cause damage in agricultural and urban areas along numerous rivers. Urban damages are most prevalent in the rapidly expanding urban areas, particularly along Wasatch Range streams in Utah and those streams draining the east slope of the Sierra Nevada in Nevada. More than one-third of the region's $10 million average flood damages occurred in urban areas in 1975. A 37 percent increase in total flood damages is projected for 2000.

Ground Water

Ground water is an important resource of this region. It supplements the low flow of the perennial streams, and many towns in the interior part of the region depend on it for their requirements. There are 230 known ground water basins in the Nevada portion of the region, some 150 of which contain substantial water reserves that are only slightly developed. There is relatively little overdraft of ground water in the region. Figure 16-5 shows the major productive aquifers.

Available storage of ground water is estimated at 171 trillion gallons, while estimates of total stored ground water appear large (944 trillion gallons). The amount that can be practicably withdrawn from any given area is limited by quality, distribution, and allocation.

The recharge rate in most aquifers is low, and overuse will result in a continual lowering of ground water levels. Withdrawals are governed by statutes of the various States. Some basins have legal limits to annual withdrawals.

Generally, in areas of natural recharge, the ground water is fresh; in areas of natural discharge in the vicinity of terminal lakes and sinks, the ground water is commonly saline to briny (1,000 to 35,000 mg/l). Saline water also occurs locally in the vicinity of thermal springs and in areas where the aquifer system includes rocks that contain large amounts of soluble salts. In any valley with no outlet, the lowest point becomes the site of a terminal lake, sink, or playa. Here, natural salts are concentrated by evaporation and locally saline ground water is usually present. In most places, there is a progressive increase in dissolved solids with increasing depth; however, there are exceptions where shallow ground water is more highly mineralized than deep ground water. Ground water having excessive concentrations of fluoride occurs in many areas, occasionally in the domestic supplies of smaller towns. Arsenic, boron, and other minor constituents are found in ground water in some locations, especially in subregion 1603.

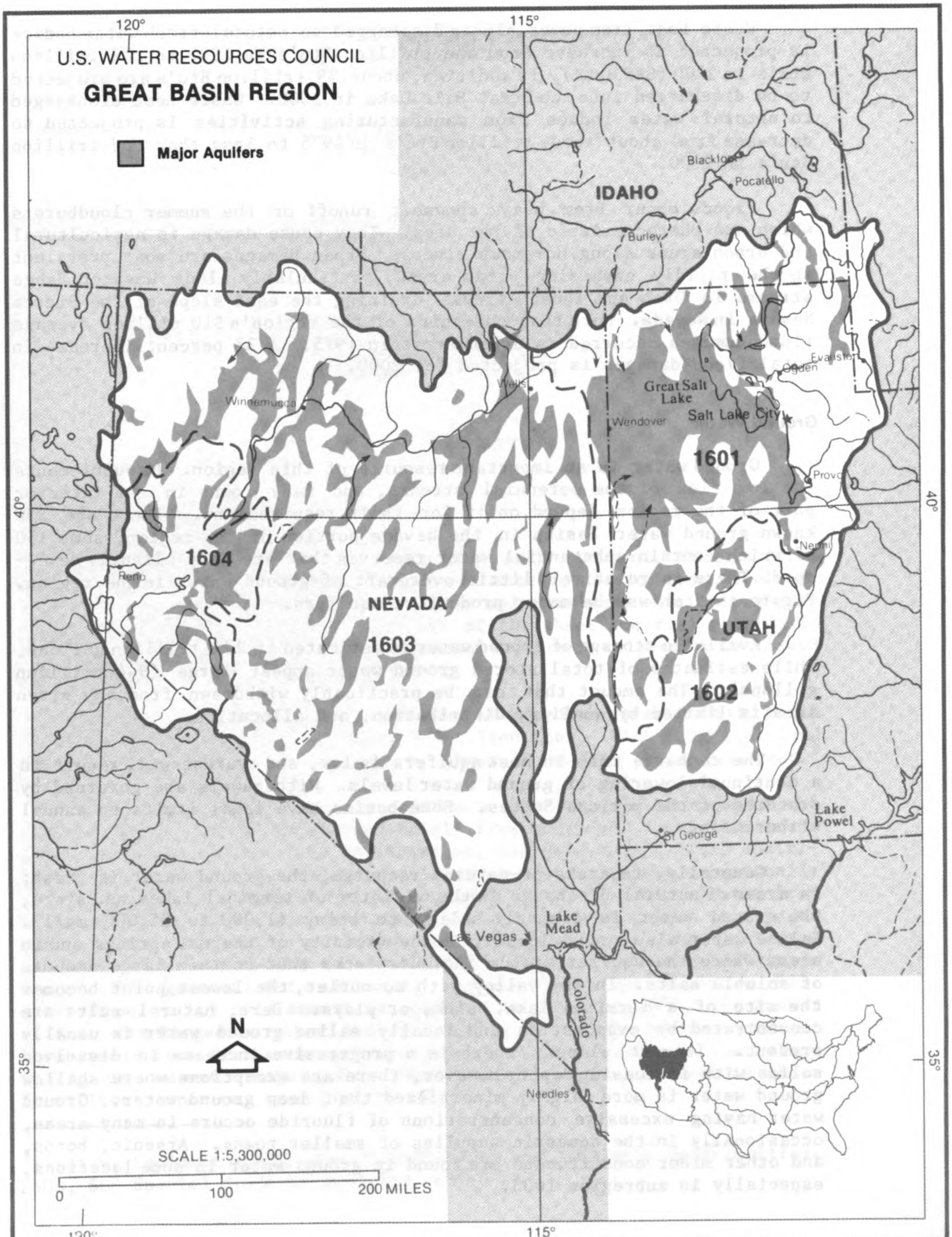


Figure 16-5. Major Aquifers

Water Withdrawals

The degree to which water is available for withdrawal is limited by occurrence, physical conditions, laws, administrative or institutional regulations, customs, patterns of use, purpose of use, and economics. Availability depends on the set of limitations selected.

The estimated average annual precipitation in the Great Basin Region is about 11 inches, producing about 82 million acre-feet of water on the 89 million acres of area. Most of this water is consumed in place by vegetation or evaporated from ground and water surfaces. Only about 8 percent becomes available as surface and ground water flow.

The use of the water resources in the region is not startlingly different from the uses in other western regions. Following the example set by the early Mormon settlers, the major use from the standpoint of both diversion and depletion is for irrigation. Other uses, not necessarily in the order of their importance or quantity used, include water for livestock, for industry, including mining, and for municipal use, which is increasing rapidly. Power generation, either from fossil fuels or nuclear energy, demands large quanitities of water for cooling purposes. Hydroelectric power generation utilizes heat in a stream, but consumptive use is primarily confined to evaporation from its ponding or single-purpose reservoirs. Although not a large consumer, recreation does demand the use of water surface area to fulfill its needs. Another important demand is for fish and wildlife. This can include not only water to maintain habitat for various kinds of wildlife and minimum flows in streams for fisheries, but selected areas in the Great Basin Region that are managed purposely for migratory waterfowl habitat.

Total water withdrawn from streams in 1975 averaged about 7,991 mgd. Irrigation accounts for about 6,969 mgd of this, more than 87 percent of the total withdrawal. The amount of water withdrawn for irrigation is expected to decrease by 16 percent by 2000. Withdrawals for domestic use in 1975 were about 340 mgd and are anticipated to rise to about 475 mgd in 2000, an increase of 40 percent. Water withdrawn for mining is also significant in the Great Basin Region. This use accounted for withdrawal of 145 mgd in 1975 and is expected to increase by more than 88 percent between then and 2000 to a usage of 273 mgd. Other water withdrawals, excluding those for manufacturing and steam electric, were 392 mgd in 1975 and are expected to be 505 mgd by 2000. Surface water withdrawals for manufacturing and steam electric were 112 mgd and 33 mgd, respectively. Estimated withdrawals for these purposes in 2000 are 98 mgd for manufacturing uses and 82 mgd for steam electric uses.

The NF estimate of 1975 ground water withdrawals is about 1,424 mgd, of which 591 mgd were mined. This represents about 18 percent of total withdrawals. Approximately 2,000 pumped wells have accounted for most of the withdrawals from wells in the region for a number of years. Individual yield rates of these wells are as great as 8,600 gpm (gallons per minute) and the specific capacity may be as great as 3,000 gpm per foot of drawdown. The average pumping rate, however, is about 1,000 gpm and the average specific capacity is about 43 gpm per foot of drawdown.

The large withdrawals along the eastern margin of the region in subregions 1601 and 1602 are typically in well-watered areas, and ground water levels fluctuate from year to year but remain relatively stable over the long term. However, concentrated pumping causes localized overdrafts in a few areas. Similar conditions exist in subregion 1603 and in several valleys in the northern portion of subregion 1604. In the drier parts of the region, some ground water pumpage is from storage. Consequently, water levels in a few areas will decline for many years before relative equilibrim will be reached.

Total withdrawals are expected to decrease from a 1975 total of 7,989 mgd to about 7,258 mgd in 2000. This decrease assumes increasing irrigation efficiencies and more reuse of withdrawn water. Figure 16-6 shows the division of water withdrawal by purposes in the region for 1975 and that estimated for 2000.

Water Consumption

Water withdrawn from ground water or surface sources is seldom entirely used. Return of unconsumed water to streams makes it available for reuse in downstream areas. The portion of the withdrawals actually consumed by evaporation, return to ground water, incorporation in processed foods, and in other ways is relatively small and varies according to the nature of use.

While total withdrawals from surface and ground water are projected to reduce in the future, the amount of water consumed appears likely to increase from about 3,778 mgd to about 4,036 mgd.

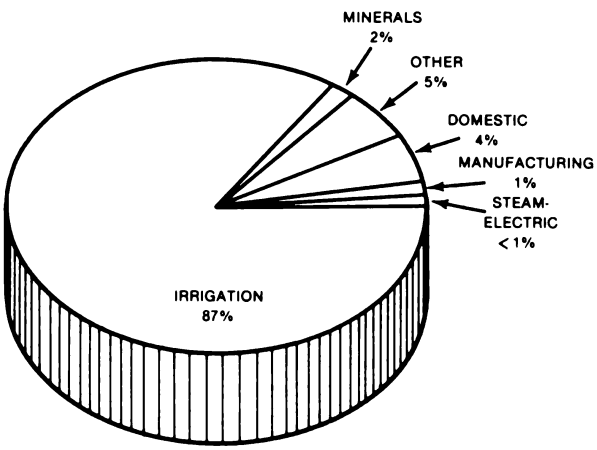
Domestic consumption of water in 1975 was about 130 mgd, approximately 38 percent of the amount withdrawn for that purpose. This percentage is expected to almost remain the same in 2000 as domestic consumption increases to 179 mgd. Consumption of water for manufacturing is projected to rise from 24 mgd in 1975 to 77 mgd in 2000. Mining industry consumption of water totaled 28 mgd in 1975 and is expected to increase to 64 mgd in 2000. Water consumption for irrigation is projected to decline from 3,225 mgd in 1975 to 3,196 mgd by 2000 as withdrawals for that purpose are reduced.

Figure 16-6 shows the distribution of consumption of water in 1975 and that for 2000 by NF estimates. Ground water consumption can be expected to increase in the future. Reservoir and pond evaporation is a depletion not included as consumption.

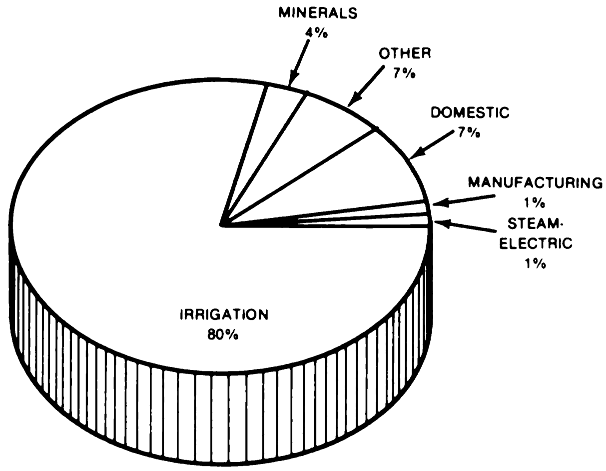
Instream Use

There are many water uses in the region which do not require withdrawal of water from the stream and which do not consume water. Principal types of uses are water associated recreation, fish and wildlife propagation, hydroelectric power production, and waste disposal including salinity control. These purposes require minimum levels of water quantity and quality.

ANNUAL FRESHWATER WITHDRAWALS

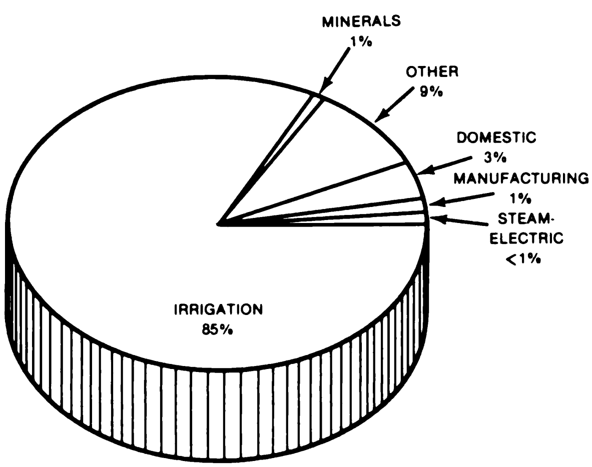


1975
Total Withdrawals — 7,991 MGD

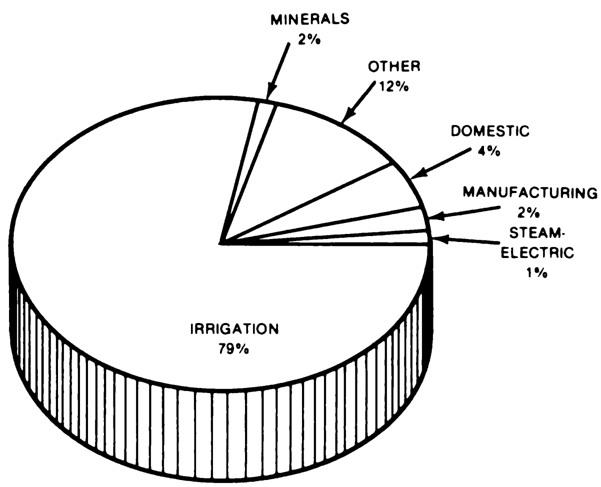


2000
Total Withdrawals — 7,258 MGD

ANNUAL FRESHWATER CONSUMPTION



1975
Total Consumption — 3,779 MGD



2000
Total Consumption — 4,036 MGD

Figure 16-6. Withdrawals and Consumption

In whatever manner instream flow uses are described, satisfaction of those uses depends on how much unappropriated water is available in the stream. The larger streams in the region are covered by more than 130 final and pending Federal or State court decrees specifying manner of use, how much water (rate of diversion and season total), place of diversion and use, and duration of use. One very important fact is that in periods of minimum flow, many of the smaller streams and some of the larger streams in the Great Basin Region have reaches which become completely dry. In most cases, in most years, the variation between high flow and low flow is extreme.

Water that is available in the region's streams is distributed under the court decrees according to a time priority system. In times of shortage, the older rights are served in preference to the more recent rights. These decreed water rights and the flows which result in a watercourse with the exercise of these rights have scant relation to instream flow needs. With the exception of hydropower, relatively little success has been achieved to date in quantifying instream flow needs in the region. At present, tentative investigations are being conducted in both Utah and Nevada to define instream flow needs using physical factors relating geometry of the watercourse, flow rate, temperature, and biologic indicators.

Not all instream uses of water are adequately met in the Great Basin Region. Often fishing is not optimum because of streamflow fluctuations and corresponding temperature variations, sediment, poor food supplies for fish, and fish losses into irrigation diversions. Additionally, in some areas, fish are not able to spawn due to impassable dams constructed on major spawning rivers and streams. In construction of new reservoirs, consideration will need to be given to minimum flows and maintenance of minimum pools for fish and wildlife. However, provision of these features must be in accordance with water laws, compatible with existing water rights, and should be balanced against the value of other uses.

While the existing variety and quantity of water-based recreation facilities are generally good in the region, increasing requirements for more water-based recreation are expected as resident and tourist population increases. As the requirement increases, new areas will need to be developed and new facilities will need to be established along streams, lakes, and reservoirs.

The increased development and use of water in the Great Basin has in some cases, restricted wildlife access to natural sources of water; in other cases, access has been eliminated. Other factors affecting wildlife watering include the continued physical presence of domestic livestock or human activity at or near water sources. One solution is for the wildlife management agencies to acquire water rights for wildlife purposes at the various natural water sources. This procedure has been used in Utah, but not in Nevada.

Hydroelectric power generation in the region is very small, and constitutes a declining portion of total production. Most of the small hydroplants constructed near the turn of the century were phased out as they became obsolete and, generally, only more recent plants continue to operate. Instream flow needs for hydropower are estimated but are not expected to grow considerably except in connection with additional hydropower development proposed to use water imported through the Bonneville Unit of the Central Utah Project. The instream flow approximations (IFA) for fish and wildlife are as follows:

Subregion	IFA (mgd)
1601	1,656
1602	278
1603	554
1604	901

These represent flows of the combined streams flowing out of each subregion. The IFA levels cannot be achieved under existing patterns of water use and water rights.

Water Supply and Demand

The total demand for water in the Great Basin Region is relatively low in comparison to its area because large expanses are undeveloped mountainous or desert areas and population densities are low. However, needs and opportunities for water use generally exceed the available supply in many of the region's subareas. Lack of plentiful supply of water has been and is expected to continue to be a major impediment to extensive economic development.

The total available streamflow for the region is estimated at 5,750 mgd. Only the Rio Grande Region has less. Flows are largely committed for many of the region's streams and actual withdrawals exceed the available streamflow since return flows are frequently reused. Average water depletions (consumption plus evaporation) were estimated at 4,105 mgd in 1975 and are projected to 4,367 mgd in 2000. This is about 71 percent of available flows in 1975 and 76 percent in 2000. Available flows include imports but not water evaporated from ponds, reservoirs, lakes and streams, or used by natural vegetation in the region.

Imports to the region are made by transregion diversions from the Upper Colorado Region to subregion 1601 and from the Lower Colorado Region to subregion 1602. Natural river inflow occurs from the California Region to subregion 1604. This will reduce somewhat as additional uses occur in California.

Comparative Analysis

Table 16-5 compares the National Future (NF) and State-Regional Future (SRF) estimates of streamflows and water needs in the Great Basin Region.

The NF estimate for total water withdrawals is 75 percent of the SRF estimate in 1975. The NF projections call for a declining total water withdrawal for 1985 and 2000, whereas SRF projections call for a small increase in total water withdrawals. For 2000, the SRF estimates are about 58 percent larger than those of the NF. A portion of the NF projected decrease in total water withdrawals is due to expected reductions of agricultural withdrawals by about 16 percent between 1975 and 2000. The comparable data for the SRF calls for only a 2 percent reduction.

Total NF water consumption estimates are consistently less than the SRF estimates for the next 25 years. NF agricultural consumption estimates alone are less than the SRF figures by 16 percent in 1975 and by 21 percent in 2000. The SRF estimates are double those of the NF for the consumption of water for steam electric purposes; the 1975 estimates are double those of NF. However, data for 2000 show a complete reversal of anticipated needs, as NF estimates for steam electric purposes are double that of the SRF. Despite these large differences, the amount of water involved in this use is small compared to other uses. Much of the difference between NF and SRF water requirements is attributable to the exclusion of marshland water use from the NF estimates. According to the SRF, there is a considerable amount of water use for managed and unmanaged marshlands between the last gaging station on the major streams and the terminal lakes. The most drastic difference in the SRF and NF data concerns ground-water withdrawals; whereas NF data estimate 1,424 mgd for 1975, the SRF estimates only 20 mgd.

Table 16-5.--Socioeconomic and volumetric data summary: the Great Basin Region

Category	1975		1985		2000	
	NF	SRF	NF	SRF	NF	SRF
SOCIOECONOMIC DATA (1000)						
Total population	1,262	1,374	1,464	1,781	1,739	2,448
Total employment	517	550	626	756	767	1,058
VOLUMETRIC DATA (mgd)						
-Base conditions-						
Total streamflow	5,750	NE	5,750	NE	5,750	NE
Streamflow at outflow point(s)	2,562	2,562	2,057	NE	1,858	NE
Fresh-water withdrawals	7,991	10,683	7,316	10,813	7,258	11,490
Agriculture	7,002	7,063	6,154	6,946	5,861	6,931
Steam electric	33	8	65	12	82	22
Manufacturing	112	89	93	148	98	327
Domestic	340	348	399	452	475	613
Commercial	38	[a]	45	[a]	55	[a]
Minerals	145	187	206	285	273	371
Public lands	319	363	351	400	411	467
Fish hatcheries	2	2	3	3	3	3
Other	0	2,623	0	2,567	0	2,756
Fresh-water consumption	3,779	6,805	3,765	7,088	4,036	7,368
Agriculture	3,258	3,857	3,116	4,029	3,232	4,087
Steam electric	3	6	42	10	52	20
Manufacturing	24	25	42	51	77	135
Domestic	130	155	151	202	178	273
Commercial	17	[a]	19	[a]	22	[a]
Minerals	28	61	44	105	64	99
Public lands	319	361	351	398	411	464
Fish hatcheries	0	0	0	0	0	0
Other	0	2,340	0	2,293	0	2,290
Ground-water withdrawals	1,424	20	NE	24	NE	28
Evaporation	327	2,469	331	2,411	333	2,336
Instream approximation						
Fish and wildlife	3,389	0	3,389	0	3,389	0

NE - Not estimated.

[a] SRF domestic water use includes commercial and institutional requirements.

Problems

Pollution

Water quality in the Great Basin Region varies from excellent to poor. Water from the mountainous areas where most streams and rivers begin is of good quality in headwaters areas, but it is degraded in downstream areas by irrigation return flows and municipal sewage treatment plant effluents.

Since the region is almost totally a hydrologically closed basin, larger streams and rivers eventually terminate in sinks or lakes. Evaporation increases salinity there to levels high enough to interfere with uses of the lakes for recreation, fish and wildlife, and other purposes. Upstream depletions increase surface water salinity downstream. Salinity is sufficiently high in the lower Sevier-Beaver Basin to affect crop yields and suitability of the water for fish and wildlife. Evapotranspiration from phreatophytes and inefficient canals and distribution systems contribute to the salinity problem.

Ground water is generally saline in the vicinity of most terminal lakes and sinks. Some salinity in ground water also occurs from high salt content in the geologic formations through which the water passes or in which it is found. This is a particular problem in the Bear River Basin. Other ground water quality problems occur from excessive fluorides. Poor ground-water quality is a major problem in the Bear and Walker basins.

Sediment pollution is a significant quality problem on many streams as discussed under "Water" in the previous section.

Some streams of the region also have excessive nutrients stemming from municipal sewage plant effluents, irrigation return flows, and septic tank effluents. Bacteriological pollution occurs from effluents from food processing plants. Some 93 million pounds of BOD were generated in 1973, preponderantly in subregion 1601. About 43 million pounds of BOD were discharged to water. This amount could be cut approximately in half by improved technology and systems. Many of the water quality problems occur as a result of effluent from recreational sites and activities particularly in the Bear, Weber, Jordan, and Carson-Truckee basins.

Erosion and Sedimentation

Soils in the Great Basin Region vary from loamy to clay and are subject to severe erosion in many areas. Consequently, erosion and sedimentation are widespread problems. Streambank erosion is a significant problem in the Sevier-Beaver and Walker basins and also, a problem in the Bear Basin. See "Water" in the previous section.

Flooding

Flooding in the region occurs from winter rains, summer cloudbursts, and heavy snowmelts. Both rural and urban areas are subject to damage throughout the region. Flooding is most severe in the Jordan and Sevier-Beaver basins and is only considered a minor problem in the Bear Basin. A significant flood problem exists in the vicinity of Reno, Nevada, along the Truckee River.

Significant flooding occurs around lakes where varying water levels damage surrounding development. This problem is particularly acute in the Bear and Jordan basins. There is a need for development and financing of measures to control lake levels at Utah Lake, Great Salt Lake, Walker Lake, and Pyramid Lake in particular.

Lack of adequate drainage in some urban areas causes flooding. There is a need for storm drain trunk lines in the Weber, Jordan, and Great Salt Lake basins.

Water Quantity

Surface water resources of the Great Basin Region are poorly distributed both geographically and in time. Most runoff occurs at the mountainous borders, thereby largely limiting the area suitable for development. The scarcity of water is a major impediment to further economic development and many opportunities remain unfulfilled. The areas in which future development either is or will be most constrained by lack of water are the Jordan, Humboldt, Walker, and Carson-Truckee basins and the Central Region area.

The shortage of water in the region increases in importance of multipurpose use. However, conflicts frequently arise between use of the available water for fish and wildlife and other instream uses and various withdrawal purposes. Future increases in irrigation efficiency are expected to result in greater depletions which will increase competition for water and be detrimental to instream uses which have been sustained by return flows. This problem is particularly severe in the Sevier-Beaver Basin. Little progress has been made to date on quantifying instream flow needs for the region.

Runoff in the Great Basin is distributed seasonally with most of each year's discharge occurring in a three month period of spring snowmelt. Because of the variability of supply, considerable storage is required for effective and dependable water use. The need for storage facilities is greatest in the Bear, Humboldt, Carson-Truckee, and Jordan basins.

Only a small portion of the precipitation in the region is available for use. Evapotranspiration rates are high and phreatophytes use large quantities of water. Use of the remaining water is hampered by inefficient canals and distribution systems in some areas. Inefficient facilities are a significant problem in the Bear Basin.

Ground water is widely distributed through the region and is used to supplement surface water supplies in the eastern and western border areas. In the central parts of the region, ground water is relied on relatively more extensively for irrigation, domestic use, and other purposes. Recharge rates are generally low throughout the region and localized overdrafts occur, especially where high irrigation and municipal demands have developed. A long term decline in ground water levels is expected in more developed parts of the region.

Water Surface

Water surface area is not presently a recreation problem in the Great Basin Region. However, recreation demands are expected to increase substantially in the future, requiring new facilities for convenient use of existing water surface areas.

Other

Institutional Issues

Major institutional issues in the region include existing or desired conflicting withdrawals for various purposes at Bear Lake and in the Carson-Truckee Basin, lack of legal controls on ground water recharge (Jordan Basin), and overappropriation of water (Sevier-Beaver Basin). Other issues concern conflict over provisions for shoreline access at Bear Lake, and unresolved water rights in the Bear Basin.

Congressional ratification is pending for interstate compacts on the Columbia River and on the Carson-Truckee and Walker Rivers. Settlement of the compacts is important for effective management of waters in the Snake River Basin and the water level in Pyramid Lake.

There are serious Federal-State conflicts in development in the Snake, Humboldt, Walker, and Carson-Truckee basins and in the Central Region area. Non-Federal development is hampered by confusion resulting from the rapid proliferation of Federal programs, regulations, and other actions. Public involvement procedures are a major emerging issue.

Urbanization

Prime agricultural land in the region is in limited supply and some of what is available is being lost to urbanization. Expansion of urban areas is also producing conflicts between agricultural and urban interests concerning use of available water.

Geothermal Energy

There is a need for increased knowledge of geothermal reservoirs in the region and their potential for production of steam and hot water.

Financial Issues

The principal financial issue in the region is the source of funding to meet the high cost of implementing water quality management plans, particularly in the Weber, Jordan, and Sevier-Beaver basins. Federal financial assistance may also be required to help resolve the region's widespread and serious flood problem.

Fish and Wildlife

Development and use of water has restricted access to natural water sources by wildlife and, in some cases, eliminated access. Water rights for wildlife may be necessary in the future. Impassable dams have also blocked travel by fish to major spawning streams.

Fishing is not optimal in the region due in part to flow fluctuations and water quality problems. Phreatophyte removal in the Walker and Carson-Truckee basins may adversely impact fishing, hunting, and wildlife habitat.

Individual Problem Areas

The Utah Division of Water Resources and the Nevada Division of Water Resources have delineated ten areas within the Great Basin Region. Within these areas are significant problems concerning land and water resources. Specific problems affecting each of these areas have been described and evaluated. The problem areas indentified are:

1. Bear River area
2. Weber-Davis area
3. Jordan River area
4. Great Salt Lake area
5. Sevier-Beaver area
6. Snake River Basin area
7. Central Region area
8. Humboldt River Basin area
9. Walker River Basin area and
10. Carson-Truckee River basins area.

The location of the problem areas selected for detailed analysis is shown in Figure 16-7a. A tabulation of the type of problems found in each area is presented in Table 16-7b. The table illustrates the problems identified for each subregion by Federal agency representatives. A summary describing each area, its problems and their effects, follows.

1. Bear River Area

Description

The Bear River problem area is basically the area drained by the Bear River and its tributaries. This area includes Box Elder, Cache, and Rich Counties in Utah, and Oneida, Franklin, and Bear Lake Counties in Idaho. Other counties in the Bear River Drainage, but not included in subregion 1601 are Lincoln and Uintah Counties in Wyoming, and Caribou County in Idaho. The principal population centers within the problem area include Brigham City and Logan in Utah, and Preston, Malad, and Montpelier in Idaho.

The Bear River rises on the northern slope of the Uintah Mountains in Utah at an elevation of about 11,000 feet. Its headwaters are but 90 miles from its mouth, yet it meanders 500 miles in a circuitous course in reaching the Great Salt Lake. In its travels it makes five State line crossings in three States. The Bear River is the largest tributary to

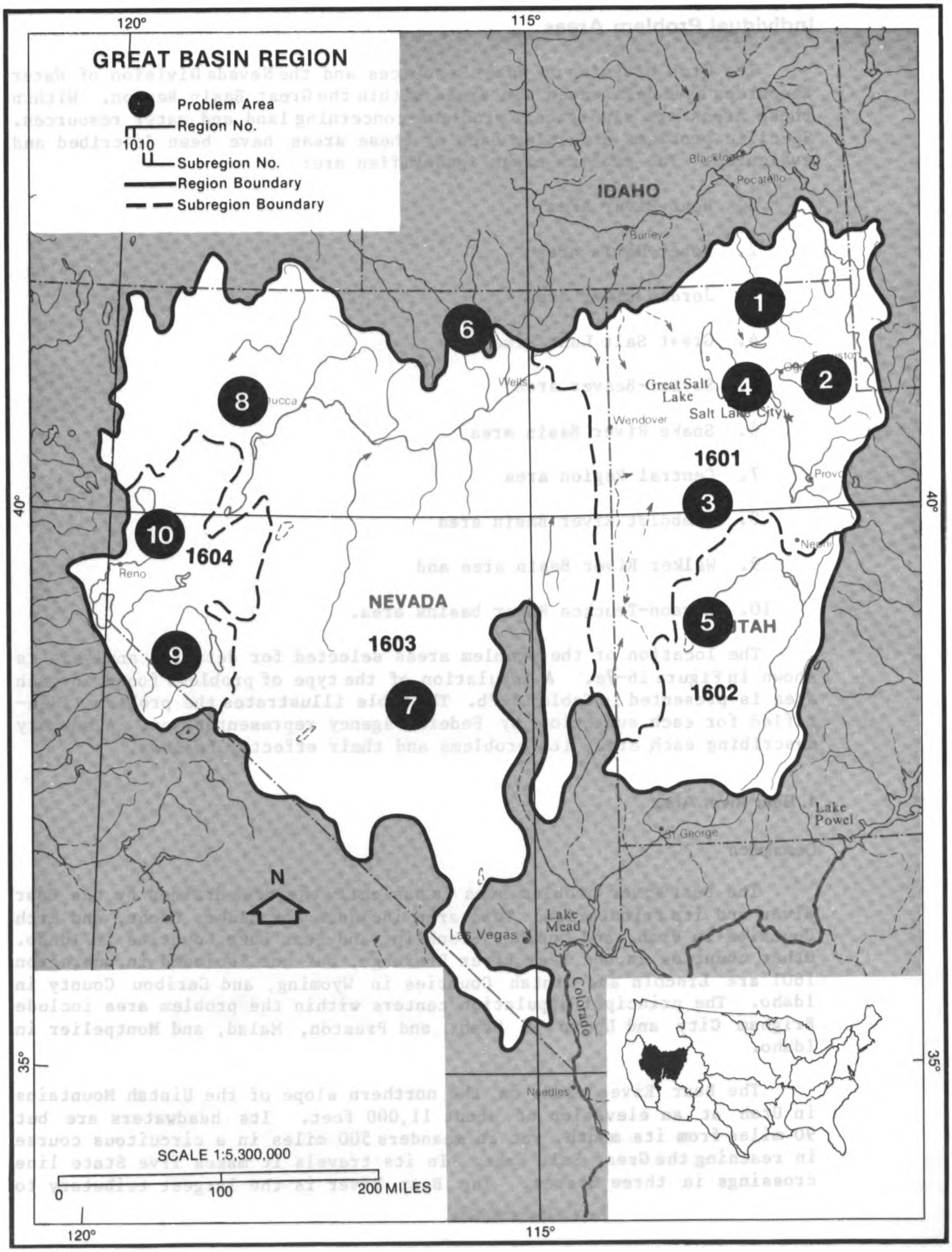


Figure 16-7a. Problem Map

GREAT BASIN REGION (16)

PROBLEM MATRIX

Problem area		Problem issues (O= Identified by Federal Agency Representatives; X= Identified by State-Regional Representative)													
No. on map	Name	Water quantity				Water quality				Related lands					
		Fresh surface	Ground	Marine and estuarine	Surface/depth	Fresh surface	Ground	Marine and estuarine	Surface/depth	Flooding	Drainage	Erosion and sedimentation	Dredge and fill	Water related use conflicts	Other
Subregion 1601	Bear-Great Salt Lake	O	O			O				O		O			O
Area 1	Bear River	X				X	X			X		X			X
2	Weber-Davis					X				X					
3	Jordan River	X	X			X				X					X
4	Great Salt Lake				X	X				X					X
Subregion 1602	Sevier Lake	O	O			O				O		O			O
Area 5	Sevier-Beaver	X	X			X				X		X			X
Subregion 1603	Humboldt-Tonopah Desert	O	O			O				O					O
Area 6	Snake River Basin	X								X		X			X
7	Central Region		X				X			X					X
8	Humboldt River Basin	X	X			X	X			X	X	X			X
Subregion 1604	Central Lahonton	O								O		O			O
Area 9	Walker River Basin	X	X				X			X	X	X			X
10	Carson-Truckee River Basins	X	X				X			X		X			X

Figure 16-7b. Problem Matrix

the Great Salt Lake, and the largest stream in the North American Continent that does not reach the ocean. It drains an area of 4,776,000 acres (7,463 square miles) in the States of Idaho, Utah, and Wyoming.

Bear Lake straddles the State line between Utah and Idaho in Bear Lake and Rich Counties. It was converted to a storage reservoir in 1918 for irrigation and hydroelectric power uses by constructing inlet and outlet canals to the Bear River.

In terms of water resources, the Bear River Basin is one of the more richly endowed parts of the Great Basin Region, but the least developed except for hydroelectric power generation. A great potential for agricultural and recreational development exists in the area. There are approximately one million acres of cropland in the basin, about one-half of which is irrigated. Practically all of the water in the Bear River has been used at least once for hydroelectric power generation and all of it that reaches the Great Salt Lake has been used several times for approximately 900,000 acre-feet of water flow into the Great Salt Lake each year, most opportunities for further water use depend upon adjustments in hydroelectric power uses.

Problems

Water Issues

One major water resources problem in the Bear River Basin is the lack of large storage facilities. The timing and distribution of the available water supply is not coordinated with drop and managed wetland needs in areas lacking storage facilities. In addition, many canals and distribution systems are inefficient.

Downstream from Bear Lake, many municipal and industrial wastes are discharged into the Bear River. Present water quality limits some uses of the water for recreation and as a fishery. Water quality problems also exist on tributary streams such as the natural high salt content in the Malad River and heavy sediment loads of most other streams. Intensive recreation and inadequate sewage facilities are becoming a major cause of water quality problems at Bear Lake. Ground water quality is also poor in Box Elder County causing problems in the domestic water supply for small communities.

Related Land Uses

Flooding along the Bear River and its tributaries is primarily associated with snowmelt runoff during the period of April through June. Major floods inundate public facilities and developments at Evanston and Cokeville, Wyoming; Montpelier, Idaho; and Smithfield and Logan, Utah. Limited agricultural developments on the flood plains of mountain valleys and the developments along the major streams in the lower valleys of the basin are subject to flood damages. About 60,000 acres of range, cropland, and rural developments are periodically inundated.

Flooding around Bear Lake is due to coincidence of high water stages (stored water for hydropower and irrigation) with moderate to high winds which create waves damaging recreation homes, beaches, and shoreline around the lake perimeter. Flood plain occupancy around the lake adds to the damages incurred.

Streambank erosion occurs along more than 1,000 bank-miles of stream channel, principally during high runoff periods, affecting public facilities and other improvements at critical locations. Generally, agricultural lands are affected as streambanks are undercut and channel changes impact on land use. Associated effects include degradation of fish and wildlife habitat, and sedimentation which reduces channel capacity in downstream reaches.

Conflicts exist in the national forest areas of the Bear River problem area between land uses for Forest Service programs, wildlife, and recreation. No new Federal action is required, however, as these problems are being considered in ongoing Forest Service programs.

Around Bear Lake, land use conflicts exist between recreation, agriculture, land development, and provision of public access to the shoreline areas. No Federal action is necessary in response to these problems since they are State and local issues which must be resolved at those levels of government. The Bear Lake Regional Commission, a bi-State agency including Rich County, Utah, and Bear Lake County, Idaho, has been formed to deal with the problems pertaining to Bear Lake and the surrounding area. The Commission is addressing a wide range of problems which occur around the lake including those dealing with pollution, public facilities and access, zoning, and flooding.

Institutional and Financial Issues

Conflicts exist at Bear Lake between water withdrawals for electric power generation, recreational use of the lake, and preservation of the lake. No action by the Federal Government is necessary to resolve the conflicts since they hinge on institutional and water rights matters which will be resolved between and within the States of Idaho and Utah.

Adverse Effects

The States of Idaho, Utah, and Wyoming are negotiating modifications to the Bear River Compact. If the State legislatures fail to ratify the compact modification, or if the United States Congress fails to consent to it, or the President of the United States fails to sign it, there will be a major adverse effect on water resources develoment in the Bear River Basin.

Without a major water development project, dilution water to relieve water quality problems will not be available. The Federal Bear River Migratory Bird Refuge is in need of 120,000 acre-feet of storage water. If this amount of storage is not provided for the refuge, a loss of

50,000 acres of marshland and reduction of 33,000 recreation trips per year could result. Storage for approximately 300,000 acre-feet of water is also needed for 125,000 acres of new irrigated cropland. If this storage is not built it will result in the loss of approximately $10 million annually in agricultural benefits.

With no further Federal action to control and improve water quality, only minor adverse effects would result since State health programs and regulations appear to be solving the problem.

If existing land use conflicts are not resolved, abuses of Forest Service land may result along with an increase in the number of complaining and dissatisfied citizens.

2. Weber-Davis Area

Description

The Weber Basin problem area includes Davis, Morgan, Summit, Weber, and part of Box Elder Counties in Utah. The two main tributaries in the Weber River drainage basin are the Ogden and Weber Rivers. The Ogden River is the largest tributary and joins the Weber River in the valley area just before the rivers terminate in the Great Salt Lake.

The Weber Basin problem area contains over 500,000 acres of arable land of which about 160,000 acres are now irrigated. The climate, and consequently the land use, differ considerably in various parts of the area. The valleys in Davis and Weber Counties which are located along the Wasatch Front, have frost-free periods of 125-130 days.

The Kamas Valley has a much shorter growing season with frost-free periods from 70-90 days. The lower valleys receive from 16 to 20 inches of precipitation annually, while the high mountain peaks receive up to 40 inches.

For the most part, this problem area remains quite rural in nature, but it contains the second highest concentration of population in the State of Utah, located from North Salt Lake - Bountiful on the south to Ogden on the north. The major industry in the area is the complex of oil refineries located in Davis County. The major employer is the Federal Government with Hill Air Force Base, Defense Depot Ogden, and a regional Internal Revenue Service Center in Ogden.

The water resources outlook in the area is favorable. Construction of the Ogden River, Weber River, and Weber Basin projects by the U.S. Bureau of Reclamation has provided both storage and flood control. Willard Bay, which is a part of the Weber Basin project, is a large storage reservoir located below the confluence of the Weber and Ogden Rivers. This reservoir is unique in that it is the only reservoir in the area that provides storage at the lower end of a river. These projects have greatly improved the domestic and agricultural use of an excellent water supply.

Problems

Water Issues

The major water issue of the problem area is maintenance and enhancement of the water's chemical, biological, and physical quality. Normal water quality problems are developing with increasing population. Biological pollution of water supplies is a particularly significant problem in the mountain areas where recreational developments such as summer homes and ski developments are attracting increasing numbers of people.

Ongoing programs under Public Law 92-500 (i.e., Sections 201, 208, 301, and 402) are expected to resolve existing and emerging water quality problems. There are 208 studies presently underway in Davis, Morgan, Summit, and Weber Counties. Recommendations for best management practices should soon be available.

Related Land Issues

Flooding in Davis and Weber Counties, particularly around the cities of Ogden, Morgan, Farmington, and Bountiful, is the problem most dependent upon increased Federal action for solution. Flood problems in the Weber River Basin are associated with snowmelt runoff from watersheds of the Wasatch Mountains and increased runoff of rainfall from urban developments. Approximately 34,000 acres of land in these two counties are subject to flooding including forest, range, croplands, and both rural and suburban developments. Local funding and ongoing Federal programs have been effective in resolving some local flooding problems and constructing some storm drain systems. Additional funding is needed to assist with major storm drain trunklines and to assist in investigating and implementing comprehensive flood control plans.

Land use conflicts due to development and urbanization are significant in the Weber Basin problem area, particularly as they relate to high-quality agricultural land. Most of the high-quality agricultural land is located in Davis and Weber valleys, which are the areas of greatest urbanization pressures.

Institutional and Financial Issues

The major financial issue affecting the Weber Basin problem area is the expected high cost and source of funding to implement recommendations resulting from water quality planning now underway pursuant to Section 208 and other sections of Public Law 92-500.

Adverse Effects

Unless effective action is taken, it is estimated that 28,563 acres of agriculture land will be lost to urbanization by 1985.

3. Jordan River Area

Description

The Jordan River problem area includes Salt Lake, Utah, and Wasatch, and Tooele Counties (except for the Great Salt Lake) in Utah. This area includes the entire drainage of the Jordan River and the rangeland and salt flats in Tooele County. The area contains over 400,000 acres of arable lands of which about 200,000 acres are now irrigated. Goshen Valley and Cedar Valley along the western side of Utah Lake contain most of the uncultivated arable lands.

The majority of this problem area is still rural in nature, but it contains the highest concentration of population in the State of Utah. Approximately half the State's population is located along the Wasatch Front from Salt Lake City through Provo to Spanish Fork. Major industries are the Kennecott Copper Company complex on the western side of Salt Lake County, and the Geneva Works of United States Steel in northern Utah County.

The water resources in this area are adequate for the existing level of develoment. However, population growth, industrial and commercial development, and agricultural production will soon be limited unless additional water supplies are found or better methods for use of existing supplies are developed. Fulfillment of many of these future water needs is dependent on completion of the Bonneville unit of the Central Utah project.

Problems

Water Issues

The water issues of the Jordan River problem area revolve largely around pressures of increasing urbanization. Population and development along the Wasatch Front between Salt Lake City and Provo are growing very rapidly and water requirements are correspondingly increasing. Surface-water supplies in southern Utah County are not sufficient to meet existing irrigation demands, and imports from the Uintah Basin are scheduled. Another surface-water quantity problem arises due to diversion demands which prevent providing the flows necessary to maintain a viable stream fishery throughout the Provo River.

The Bonneville Unit of the Central Utah project, a Bureau of Reclamation project under construction, will provide for irrigation, municipal, and industrial water needs in the Jordan River problem area until at least 1990 if completed as scheduled. The project includes importation of water from the Colorado River Basin (via Strawberry Reservoir) and development of additional supplies in the Provo River System. Major reservoirs are planned on the Provo River above Heber City in Wasatch County and on the Jordan River. Most of the imported water will be used for irrigation in southern Utah County.

Normal water quality problems are developing with increasing population. Recreational activities in the Wasatch Front Canyons, including picnicking, hiking, and skiing, are causing biological water pollution in streams which are a principal component of the municipal water supply for the area. Ongoing programs under Public Law 92-500 (i.e., Sections 201, 208, 301, and 402) are expected to control these problems. There are 208 studies presently underway in Salt Lake County and the Mountainlands District (Utah, Wasatch, and Summit Counties). Recommendations for best management practices should soon be available.

Related Land Issues

Flooding in Salt Lake and Utah Counties is the problem most dependent upon increased Federal action for solution. Flood problems in the Jordan River Basin are associated with snowmelt runoff from watersheds in the Wasatch Mountains and increased runoff of rainfall in urban and suburban developments. Cities and communities such as Salt Lake City, Provo, Springville, American Fork, Lehi, and Payson experience periodic flooding which affects residential, commercial, public facilities, and other developments. Suburban and rural flood damages occur on about 9,000 acres of flood plain lands.

Over the years, the shoreline of Utah Lake has been developed for agriculture, and flood damage now results from moderate increases in the level of the lake. Although Deer Creek Reservoir provides storage above Utah Lake the amount of storage is not sufficient to keep the lake from rising in periods of high runoff. High stages of the lake also adversely affect other land in the area as a result of high ground water levels. Attempts to reduce the flooding at Utah Lake by increasing releases down the Jordan River often result in flooding along the Jordan River. A reservoir on the Jordan River is presently being considered by the Jordan River Parkway Authority, and if constructed should alleviate the problem to some degree.

Land use conflicts due to development and urbanization in the Jordan River problem area are significant, particularly as they relate to high-quality agricultural land and wildlife habitat. Most of the high-quality agricultural land in the area is located in Salt Lake and Utah valleys, which are the areas of greatest urbanization pressure.

Provo Bay on Utah Lake and marshlands around the mouth of the Jordan River are valuable nesting and resting areas for waterfowl. Potential diking of Provo Bay under the Bonneville unit, Central Utah project would adversely affect some wildlife values and change others to obtain benefits from additional irrigated land.

Institutional and Financial Issues

Full development of the ground water resources of Salt Lake and Utah valleys is hindered by institutional and legal constraints. The aquifers are not being drawn down appreciably, and much of the inflow is spilling unused into the Jordan River. Efficient conjunctive use of the ground and surface water resources of the area requires that the aquifers be used heavily in dry years and recharged in wet years. At present, legal control of recharged water is impossible, and dewatering of aquifers causes interference with many existing small wells. It is anticipated that more efficient use will occur when impending scarcities increase the value of water and decrease public opposition to modifications of water laws and/or institutions. Federal actions would not affect this problem.

The availability of funding to implement recommendations developed under Section 208 and other water quality planning programs is expected to be a problem in the near future.

Local funding and ongoing Federal programs have been inadequate to solve existing flood related problems. Additional funding is needed to assist with construction of major storm drain trunklines and to assist in investigating and implementing comprehensive flood control plans to resolve urban flood problems and reduce flood damage along major waterways in the basin. Funding is also needed to study possible measures to better control the stage of Utah Lake or develop measures to protect adjacent lands.

Adverse Effects

Without action to resolve existing land use conflicts, significant portions of the present rangeland, agricultural and mashland areas will be lost to urbanization. The Federal Government could have some impact on this problem through purchase of critical wetlands.

Some adverse effects are anticipated in connection with the Bonneville unit of the Central Utah project. The most important of these effects in the Jordan River area is the reduction in quality of 38 miles of Class I, II, and III stream fisheries, and a significant impact on fishery values and wildlife habitat at Utah Lake. In the opinion of the State of Utah, these adverse effects are far overshadowed by the potential benefits of the Bonneville Unit, and the State has strongly endorsed the project.

4. Great Salt Lake Area

Description

The Great Salt Lake problem area includes the Great Salt Lake and the near shore area. The lake is situated in the northwest part of Utah and includes parts of Box Elder, Weber, Davis, Salt Lake, and Tooele Counties.

The lake, being the terminal point for the drainage systems of the Bear, Weber, and Jordan Rivers, is the ultimate sink for the basin. Many problems around the lake are related to the cyclic changes of the surface elevation of the Great Salt Lake. The driving force of the fluctuation in surface elevation is the large variation of inflow, which is made up of precipitation on the lake and surface and ground water inflow to it.

Another result of the lake being the terminal point of the drainage systems of the area is the high concentration of salts found there. The salinity of the lake water has varied from approximately 120,000 ppm at high lake stages to 240,000 ppm at low lake stages.

The lake and surrounding shore area supports many types of wildlife, as well as recreational, developmental, and mineral extraction uses. The interaction of the lake's character and these multi-objective uses is both unique and complex. A large potential exists for additional development of the lake's resources and uses.

Birds are the most abundant wildlife in the area, with 247 identified species. The marshes around the lake are of international importance due to their strategic position on the Pacific and Central flyways. Some three million game birds stop over at the lake from these flyways each year.

Problems

Water Issues

The water issues in the Great Lake problem area relate to the problems in the multi-objective use of the lake created by fluctuation of its surface level and the changes in concentration of its salt content which are associated with changes in its volume. The magnitude and severity of these problems vary according to the specific use and lake elevation.

Since records have been kept, the surface elevation has varied from a high of 4,211.5 feet in 1873 to a low of 4,191.6 feet in 1963. The area around the lake is flat and even moderate changes in depth cause a large change in surface area. The shifting of the shoreline causes critical problems for wildlife, recreation, and extraction industries around the lake.

Surface area and depth are particularly important characteristics with respect to wildlife in and about the Great Salt Lake. A significant rise in water level would destroy many of the natural habitats and interrupt the food chain. Conversely, a drop in the water level could convert existing islands into peninsulas, thereby providing land predators with access to nesting colonies of birds and upsetting the unique island ecosystems. A reduction of precipitation would threaten the viability of the habitats in the freshwater marshes.

Due to the natural salinity of the lake, water quality issues in the Great Salt Lake problem area relate only to the waste materials that enter the lake. With the present level of treatment of point sources and the ongoing non-point studies under Section 208 of Public Law 92-500, water quality problems in the area are expected to be minimal. Changes in the chemical concentration of the lake brines due to the fluctuation in the surface elevation primarily affect the extraction industry around the lake.

Related Land Issue

Damage due to flooding is a substantial hazard in the problem area. During the last three or four decades, the lake has been relatively low, and during this time considerable development has occurred around the lake. Between 1963 and 1976, the lake level rose from 4,191.6 feet to 4,202.25 feet. Considerable damage occurred to the development around the lake at that high water level.

Although 1977 has shown the first drop in peak elevation since 1963, recent climatological studies have concluded that the water level of the Great Salt Lake may continue to rise. One study suggests that during the next 15 to 25 years, the lake may eventually reach the 4,216 foot to 4,218 foot level.

Institutional and Financial Issues

Unresolved water rights, the Bear River Tri-State Compact negotiations, and institutional issues concerning the uses of water in the Bear River System affect the Great Salt Lake problem area.

There have been many schemes proposed for management of the Great Salt Lake. These schemes vary widely with regard to the degree they affect the water elevation in the lake: whether they are directed toward high or low water levels; whether they are most effective over a long period of time or for short periods of high inflow; and finally whether they use reduction of inflow, exportation, increase of evaporation, or storage as the means of controlling the water elevation. Various management schemes are presently being evaluated as part of the development of a comprehensive plan for the Great Salt Lake.

Adverse Effects

While there is no certainty that the climatological predictions for increased water levels in the lake will prove accurate, the studies indicate the seriousness of the possibilities. The greater danger in the near future plainly lies in higher water levels, rather than lower levels. If water levels reach the predicted 4,216 foot level, present brine industries, recreation areas, and utility and transportation facilities would be inundated, resulting in losses and damages of hundreds of millions of dollars.

A combination of water in the Great Salt Lake above an elevation of 4,305 feet plus flooding conditions caused by high water runoff in the Jordan River drainage basin would have the potential for extremely high flood damage to the Salt Lake City urban area.

5. Sevier-Beaver Area

Description

The Sevier-Beaver problem area includes subregion 1602, which contains the Sevier and Beaver Rivers as well as other smaller closed drainage systems.

The Sevier River Basin is located in south-central Utah and includes portions of Garfield, Iron, Juab, Kane, Millard, Piute, Sanpete, Sevier, and Tooele Counties. The Sevier River once terminated in the prehistoric Lake Bonneville and more recently has discharged perennially into Sevier Lake. Irrigation developments since the turn of the century have now depleted flows to the point that the only waters presently reaching Sevier Lake are occasional flood flows, drainage effluent, and ground water. Most of the residents of the basin are located in small farming communities of which Richfield is the largest. The basin is primarily an agricultural area with limited mining and manufacturing activities.

The Sevier River Basin portion of the problem area contains one million arable acres plus an additional 740,000 acres which could be arable if reclaimed by drainage. There are presently about 300,000 acres under irrigation. Annual precipitation on cropland varies from 13 inches in the Levan area to 6 inches in the vicinity of Delta.

The Beaver River Basin is part of the Sevier Lake Basin, but surface flows seldom enter the Sevier River. The major portion of the basin is located in Beaver, Iron, and Millard Counties. This area is much like the Sevier River Basin in that most of the inhabitants reside in small communities. Cedar City is the largest community in the basin. The economy in the basin is primarily agricultural but tourism, mining, and manufacturing are also significant.

There are presently 72,000 acres of irrigated land in the Beaver River Basin. There are large amounts of other arable lands in the basin but water is unavailable for their irrigation. There is negligible outflow from the basin, the ground water is being mined, and the potential for water salvage from phreatophytes is reaching a practical limit. Some small sub-basins, however, experience shortages only because of inadequate control of the supply available to them.

The water resources of the problem area are quite limited compared with the land resources in the area. Although the traditional agricultural orientation of the area is expected to continue, many energy related imports are expected to take place in the near future.

Problems

Water Issues

Water quantity issues in the Sevier-Beaver problem area revolve mainly around agricultural and wildlife demands. There is a trend in agriculture to increase irrigation efficiencies and, consequently, the consumptive use of water. This increased rate of consumption causes difficulties for downstream users who rely on inefficient upstream use and return flows to make up their water rights. Some imports from the Bonneville unit of the Central Utah project are planned to help alleviate this problem.

Increasing water demands for irrigation and municipal and industrial uses may tend to dry up some wetlands which are now providing habitat for waterfowl. Increased irrigation demands on surface water supplies will also tend to injure fisheries and draw reservoirs down more quickly, adversely affecting recreational and esthetic values of the shorelines. The reduction of fishery potential is most likely to occur in the lower reaches of the Sevier, Beaver, and San Pitch Rivers.

Ground water has been the main source of municipal water supply in the problem area and increased demands will be placed on aquifers as the area continues to grow in population. The largest new demands are expected to be in the Escalante Desert area and at the new alunite mine in Wah Wah Valley.

Minor water quality problems are developing as the population of the area increases. Ongoing programs under Public Law 92-500 are expected to control these problems. There is a 208 study presently underway in the Beaver River Drainage counties of Beaver and Iron. The counties of Sanpete, Millard, Sevier, Piute, and Juab are in a nondesignated area, but a 208 study covering these areas is presently being formulated by the Utah State Bureau of Environmental Quality. Recommendations for best management practices should soon be available.

Increasing salinity in the Sevier and Beaver Rivers from irrigation return flows is adversely affecting crop yields for downstream water users, as well as recreation and wildlife potentials.

Related Land Issues

Some parts of the Sevier-Beaver problem area are prone to floods with frequent costly inundation damage occurring to residential areas such as Richfield and Cedar City as well as to about 26,000 acres of cropland, forest, and range.

About 104 miles of streambank and adjacent land in the problem area are damaged by erosion and sedimentation. River bank treatment necessary to control flood related erosion has been found infeasible in most areas; however, some treatment is necessary and is expected to be economically feasible in the future.

Some existing grazing permits will be lost in the area in the future due to watershed stabilization needs on national forest lands.

Institutional and Financial Issues

The principal institutional problem in the Sevier-Beaver problem area is the overappropriation of water. Due to the overappropriation in the two basins, it is difficult to obtain new water rights for municipal water supplies, irrigation, and industrial uses.

Funding to implement needed water quality control programs is anticipated to be a problem in the area.

Adverse Effects

A moderate adverse effect will be felt in the problem area if no new Federal flood control projects or watershed management programs are implemented to help mitigate flood related problems.

A minor adverse effect will also be felt in the area if some Federal land management programs are not implemented in the area to help mitigate problems of conflicting land use.

6. Snake River Basin Area[1/]

Description

The Snake River Basin problem area includes all of the Snake River Basin within Nevada. This area encompasses about 3.3 million acres in the northern third of Elko County and a small part of northeast Humboldt County. The largest settlements in the area are in the vicinity of Mountain City-Owyhee (900 people) and Jackpot (400 people). The total area population is approximately 2,000.

About 1.9 million acres or about 57 percent of the problem area are National Resource lands. Other ownership in order of declining size are Humboldt National Forest (20.5 percent), private (18 percent), and Duck Valley Indian Reservation (4.5 percent). Almost 94 percent of the lands in the problem area are rangelands used for grazing, recreation, and wildlife. Other significant uses include those for woodland activities (3.2 percent), and cropland (2.1 percent). Urban-industrial uses account for only 1,000 acres (0.3 percent) of the area lands.

The amount and distribution of water in the Snake River Basin problem area is relatively abundant, compared to the area immediately south. Approximately 680,000 acre-feet of runoff in the basin are generated in Nevada on an average annual basis with about 500,000 acre-feet of this leaving Nevada as a streamflow. Additionally, about 17,000 acre-feet of streamflow come into Nevada from drainage areas in Idaho. The combined streamflow from Nevada to Idaho is estimated to be about 510,000 acre-feet on an average annual basis.

Problems

Water Issues

Water quality problems concerning withdrawals from fresh surface sources are expected to occur in the near future and to affect irrigation, livestock, metallic mining, and possibly energy production. Water rights for these uses will become important issues as the available water resources are developed. Water quality from fresh surface sources will also be of concern in relation to fish and wildlife habitat in various streams, lakes, and reservoirs.

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[1] This problem area is not within the hydrologic boundaries of the Great Basin Region but is included in the county boundary approximation of the region.

Related Land Issues

Flood erosion and sediment problems occur in the nonurban and crop areas along the Owyhee River and tributaries and at certain lakes and reservoirs.

Institutional and Financial Issues

Use, conservation, and control of the waters of the Snake River Basin problem area would be more secure if an interstate compact were in force. The Nevada Legislature previously ratified a Columbia River Compact which included the water supplies within the problem area. The compact was not ratified by some of the participating States and is therefore not effective. There has recently been a renewed interest throughout the Northwestern States in pursuing compact negotiations.

About 82 percent of the lands in the Snake River Basin problem area is owned by the Federal Government. Federal-State-private institutional conflicts have developed over a large proportion of the small isolated private base which remains. Federal and State agencies are increasingly engaged in regulating private activities, and Federal agencies are concurrently competing to enforce their own functions upon withdrawals of public domain. The most publicized conflict situations presently involve wild horses and burros and development of land and water conditions in certain areas. Other existing and emerging conflicts relate to the following:

- EPA regulations for water, land wastes, and air under Public Law 92-500 and Public Law 90-148;
- Water elements of housing plans under the Housing and Community Development Act of 1974;
- Federal-State-private ground water conflicts concerning injection wells, mining of water for private and Federal purposes, and Winters Doctrine;
- EPA drinking water regulations;
- Flood plain regulation and flood insurance;
- Dredge and fill permit programs operated by the Army Corps of Engineers;
- Various withdrawals, rulings, and activities for public lands;
- Jurisdictional control of Wildhorse Reservoir and other waters with multi-type ownerships of surrounding lands.

Adverse Effects

The present effect of the numerous existing and potential problems in the Snake River Basin problem area is not great because development in the area is still small. In some cases, regulatory stances may possibly result in mitigation of problems. However, the long term implications for unresolved problems are far reaching.

7. Central Region Area

Description

The Central Region problem area includes about 34 million acres in the center of Nevada including most of Nye, White Pine, and Esmeralda Counties and portions of Elko, Lincoln, Eureka, Lander, Pershing, Churchill, Humboldt, Mineral, and Clark Counties. The four county seats located in the area and their 1970 populations totaled 6,500 residents, or about 35 percent of the area's approximately 19,000 residents. The area is composed of about 100 closed basins, none of which contains large stream systems or surface water sources.

Land ownership in the Central Region problem area is dominated by the Federal Government. In declining order, its ownership classifications and share of the area include National Resource Lands (75 percent); Defense (10 percent); Humboldt, Toiyabe, and Inyo National Forests (8 percent); and Sport Fisheries and Wildlife Withdrawals (3 percent). About 4 percent of the area is in private ownership.

Almost 74 percent of the lands in the problem area are rangelands, used for grazing, recreation, and wildlife. Other significant uses include those for woodland activities (19 percent), and pasture and wildlife (5 percent). Urban-industrial uses account for only 37,000 acres (0.1 percent) of the area lands.

Problems

Water Issues

Shortages of fresh surface water are a minor problem in the area with respect to fish and wildlife habitat. The limited supply of ground water is expected to become a problem in the future for portions of the Central Region problem area due to the inadequacy of supply for municipal, agricultural, metallic mining, and nonhydroelectric power generation uses. Additionally, chemical quality problems will also be associated with these same uses.

Future amounts of long term sustainable ground water pumpage and its spatial distribution in the problem area will depend on the extent of use made of ground water for several purposes. Domestic uses will depend largely upon EPA drinking water regulations, economically achievable extent of treatment, quality of available supplies, proximity of basins with sufficient annual recharge, and available capital for such investments. Some small communities without economically developable alternate sources could be forced to operate expensive treatment facilities, or go long distances for water.

Related Land Uses

Flooding occurs occasionally in the problem area as the result of snowmelt and high intensity summer thunderstorms. While urban flooding is minor, major flooding occurs in nonurban and crop areas. Wind erosion is also a significant problem on unprotected croplands in a few of the larger valleys in the area during the noncropping season. In some valleys, crops occasionally need to be replanted during the cropping season due to wind scouring.

Institutional and Financial Issues

About 96 percent of the lands in the Central Region problem area are owned by the Federal Government. Federal-State-private institutional conflicts have developed over a large proportion of the small and isolated private base. Federal and State agencies are increasingly engaged in regulating private activities, and Federal agencies are concurrently competing to enforce their own functions upon withdrawals of the public domain.

The most publicized conflict situations at present involve pupfish in Devil's Hole in the Amargosa Desert, wild horses and burros, and development and water conditions in the Pahrump Valley. Additional conflicts which have resulted or will result in unresolved problems, pertain to the following:

- EPA regulations for water, land wastes, and air under Public Law 92-500 and Public Law 90-148;
- Water elements of housing plans under the Housing and Community Development Act of 1974;
- Federal-State-private ground water conflicts concerning injection wells, geothermal development, mining of water for private and Federal purposes, and Winters Doctrine;
- EPA drinking water regulations;
- Flood plain regulation and flood insurance;
- Dredge and fill permit programs of the Army Corps of Engineers;
- Various withdrawals, rulings, and activities for public lands; and
- Population limitations by municipalities.

Adverse Effects

Competition among governmental agencies at all levels for control of portions of the area's public domain can be detrimental to efficient resource management. From the viewpoint of the private land owner, the situation is one of increasing government on all levels versus the existing position and future growth of the private sector. Implications are far reaching for future development in the public lands States, although the alternatives will not be decided in the near future. Views of local people in this area range strongly from pro to anti growth and development. They are also concerned about the lack of weight given to their opinions in government decisions involving such a large area.

The various problems identified are not all severe at present because the developed base of private lands is still small. In some cases, the regulatory stance may possibly result in mitigation of problems.

8. Humboldt River Basin Area

Description

The Humboldt River Basin problem area encompasses about 18.3 million acres in the northwest and north-central portion of Nevada including all of the Humboldt River Basin (10.8 million acres) and the Black Rock Desert. The area includes significant portions of Washoe, Humboldt, Pershing, Lander, Eureka, and Elko Counties.

The most important river system of the area is the Humboldt River and its tributaries, which ultimately flow into a terminal sink. The Black Rock Desert and sizable other portions of the area are characterized by small lakes, large playas, and small streams. Some streams are perennial but the majority are intermittent. Altogether there are about 70 basins in the problem area, none of which has an outlet to the sea.

Cities, towns, and settlements of more than 500 residents account for about 75 percent of the area's population of approximately 24,500 residents. Towns and settlements of fewer than 500 residents include but are not limited to: Denio, Orovada, Hualapai Flat, Colconda, Paradise Valley, Grass Valley, Austin (Lander County Seat), Crescent Valley, Beowawe, Deeth, Lamoille, Jiggs, and Spring Creek.

About 68 percent of the lands in the problem area are National Resource lands owned by the Federal Government, and an additional 1 percent is owned by the Bureau of Indian Affairs. Private parties own about 31 percent of the area and local governments less than 1 percent.

The majority (84 percent) of the land in the area is rangeland used for grazing, recreation, and wildlife. Other uses in decreasing order are woodland (7 percent), pasture and wildlife (5 percent), and cropland (2 percent). Urban and industrial lands account for only 39,000 or 0.2 percent of the area's lands.

Problems

Water Issues

The quantity of water available in the problem area varies by place and over time in an irregular manner. Upstream storage has been proposed to mitigate this problem.

A number of problems will occur in the future with respect to availability of fresh surface water. The most serious of these problems will be water availability for crop irrigation. Other less serious problems will concern the availability of surface water for recreation, fishing, water-based hunting, wetlands, waterways, and fish and wildlife habitats. Water quality issues will also be important in association with all of the aforementioned uses.

Some issues of a minor nature will be associated with ground water. These will include both quantity and chemical quality problems attendant to use of the water for municipal, agricultural, and mining of metalics, nonhydroelectric power generation, and manufacturing uses.

Future amounts of long term sustainable ground water pumpage and its spatial distribution will depend on several factors, the full effects of which are not presently known.

Related Land Issues

Flooding occurs occasionally in the problem area as the result of snowmelt and high intensity summer thunderstorms and is a threat to lives and property. Many of the communities and settlements have been subject to flooding, as have many of the ranches in the area.

Both water and wind erosion of cropland is significant, the latter being particularly significant during the noncropping season. Water erosion is also detrimental to recreational fishing and hunting areas.

Phreatophyte management poses a major problem in parts of the area. Their removal in certain areas can provide benefits for downstream appropriators by salvaging water, but this has negative effects on fishing and hunting.

Institutional and Financial Issues

The Federal Government owns about 69 percent of the land in the Humboldt River Basin problem area. Federal-State-private institutional conflicts have developed over a large proportion of the remaining small and isolated private base. Federal and State agencies are increasingly engaged in regulating private activities, and Federal agencies are concurrently competing to enforce their own functions upon withdrawals of the public domain. The most publicized conflict situations presently involve grazing leases, wild horses and burros, and multiple use of the public lands. Additional conflicts which have resulted or will result in unresolved problems, involve the following:

- EPA regulations for water, land wastes, and air under Public Law 92-500 and Public Law 90-148;
- Water elements of housing plans under the Housing and Community Development Act of 1974;
- Federal-State-private ground water conflicts concerning injection wells, geothermal development, mining of water for private and Federal purposes, and Winters Doctrine;

- EPA drinking water regulations;
- Flood plain regulations and flood insurance;
- Dredge and fill permit programs of the Army Corps of Engineers;
- Various withdrawals, rulings, and activities for public lands; and
- Population limitations by municipalities.

Adverse Effects

The conflicts noted are not all severe because the presently developed base of private land is small. In some cases, the regulatory stance may possibly result in mitigation of problems. However, the long term implications for unresolved problems in the problem area are far reaching.

9. Walker River Basin Area

Description

The Walker River Basin includes about 2.7 million acres, of which about 2.1 million acres are in Nevada and considered as the Walker River Basin problem area. The Basin's river system is made up of the East and West Walker Rivers, Walker River, and several small tributaries. Both the East and West Walker Rivers head in California and flow into Nevada, where they merge in Mason Valley to form the Walker River. The Walker River terminates at Walker Lake, one of the large terminal lakes in the Great Basin Region. Included in the problem area are large portions of Lyon and Mineral Counties and small portions of Douglas and Churchill Counties.

Cities, towns, and settlements of more than 500 residents account for more than 90 percent of the area population of approximately 12,500 residents. Towns and settlements of less than 500 residents include but are not limited to: Topaz Lake, Wellington, Wabuska, and Whiskey Flat.

Of the 2.7 million acres in the Walker River Basin, 1.5 million acres are classified as rangeland, more than 800,000 acres are in woodland, 38,000 acres are utilized for urban and industrial uses, and about 120,000 acres are in cropland. Military land holdings include the U.S. Naval Ammunition Depot at Hawthorne. About 88,000 acres of land heavily covered with phreatophytes provide wildlife habitat and some grazing for domestic animals. Water surface area in the basin for lakes, reservoirs, and streams is estimated to be approximately 48,000 acres.

Problems

Water Issues

Issues dealing with the quantity of fresh surface water in the problem area concern the short supply for diverse purposes including metallic and nonmetallic, nonhydroelectric power generation, recreational boating, fishing, and water-based hunting. Some problems of surface water withdrawals and instream quality also exist for provision of irrigation supplies and maintenance of wetlands, lakes, and fish and wildlife habitats.

There is insufficient water in the Walker River system under present climatic conditions to satisfy upstream requirements and maintain the existing fishery in Walker Lake. Water levels are declining in the lake and salinity is increasing. These changes are expected to severely affect the fishery by 1990, plus or minus five years.

Several issues are related to ground water within the problem area. The major issues concern quantity and chemical quality as it relates to metallic and nonmetallic mining, and nonhydroelectric power generation. Other issues of a minor nature concern quantity and chemical quality for municipal and industrial uses and irrigation.

Future amounts of long term sustainable ground water pumpage from valleys and its spatial distribution will depend largely upon amounts of surface water available for potential mining of ores in Mason Valley. In the Hawthorne area, sources of ground water of acceptable quality are expected to be required in the future for municipal uses.

Related Land Issues

Flooding occurs occasionally in this problem area as the result of spring snowmelt and high intensity summer thunderstorms. Many of the communities and settlements have been subject to flooding, as have many of the ranches in the area. Flooding also has a major impact on crops.

Erosion in the problem area is significant and has a major impact on crops, recreational fishing and hunting, and a minor impact on wildlife habitats.

Phreatophyte removal also impacts adversely on recreational fishing and hunting, and to a small extent on wildlife habitat.

Institutional and Financial Issues

The most publicized conflict situations presently involve the declining level of Walker Lake versus upstream water uses. The proposed compact between Nevada and California for allocating the waters of the Carson, Truckee and Walker Rivers is before the Congress. Means of mitigating the rate of decline in Walker Lake, and of mitigating the effects thereof on the system, are being studied. Attempts at mitigation could result, depending largely upon available financing. Means for desalting the lake have been developed but costs appear to be prohibitive.

The Federal Government owns about 90 percent of the lands in the Walker River Basin problem area. Federal-State-private insitutional conflicts have developed over a high proportion of the small and isolated private base. Federal and State agencies are increasingly engaged in regulating private activities, and Federal agencies are concurrently competing to enforce their own functions upon withdrawals of the public domain.

Additional conflicts, which have resulted or will result in unresolved problems concern the following:

- EPA regulations for water, land wastes, and air under Public Law 92-500 and Public Law 90-148;
- Water elements of housing plans under the Housing and Community Development Act of 1974;
- Federal-State-private ground water conflicts concerning injection wells, geothermal development, mining of water for private and Federal purposes, and Winters Doctrine;
- EPA drinking water regulations;
- Flood plain regulation and flood insurance;
- Dredge and fill permit programs of the Army Corps of Engineers;
- Various withdrawals, rulings, and activities for public lands; and
- Population limitations by municipalities.

Adverse Effects

Conflicts over land use are not all severe because the developed base of private land is still small. In some cases, the regulatory stance may possibly result in mitigation of problems. However, the long term implications for unresolved problems are far reaching.

10. Carson-Truckee River Basins

Description

The Carson-Truckee river basins problem area includes about 5.2 million acres in the west-central part of Nevada. The Carson and Truckee basins extend westward into California where these rivers have their origins. The problem area contains a total of about 30 closed basins.

The two river systems include the East and West Carson Rivers, Carson River, Truckee River, and a multitude of tributaries. The East Fork and the West Fork of the Carson River merge in Carson Valley, near the Gardnerville and Minden area. After the merger, the river flows past Carson City and eventually into Lahontan Reservoir near Fallon. The Truckee River originates at Lake Tahoe. It flows out of the lake and trends northerly to Truckee, California, then flows northeasterly to cross the State line near Verdi, Nevada. From Verdi, the river flows through the Reno area to Derby Dam. At Derby Dam, a portion of the river continues into Pyramid Lake, one of the large terminal lakes in the Great Basin. Also, a portion is routed into the Truckee Canal, toward Lahontan Reservoir on the Carson River. Water from this reservoir is used for irrigation, recreation, and fish and wildlife habitat in the Fallon and Stillwater areas.

Included in the problem area are large portions of Washoe, Churchill, Douglas, Lyon, and Pershing Counties. All of Carson City and Storey County are in the area. Cities, towns, and settlements above 500 residents in the area account for more than 90 percent of the total population of approximately 160,000 residents.

Problems

Water Rights

Measured runoff statistics, available since 1900, indicate that there is insufficient water to fully satisfy all uses. One of the major problems in the area is whether available water supplies should be used to maintain Pyramid Lake or for other purposes.

Numerous other conflicts occur in the problem area due to the high competition for scarce land and water resources. Major problems are expected in conjunction with water use for municipal, agricultural, mining, power generation, recreational, and fish and wildlife purposes. While water rights may be transferred by purchase from one such use to another, this alternative may become seriously constrained, depending upon the outcome of the water supply question for Pyramid Lake. These issues will increase in severity and spatial distribution as water demands increase.

Issues concerning ground water quantities will develop in the area in conjunction with municipal, agricultural, livestock, watering, mining, power generation, and manufacturing uses.

Future amounts of long term sustainable ground water pumpage in the area and its spatial distribution will depend upon natural factors, such as recharge rates, quality of available supplies, and proximity of basins with sufficient annual recharge, along with the amounts of surface water available for use.

Return flows from surface water withdrawals will need to be reused to relieve the worst potential shortages. Quality problems will increase in the amount of water involved and in spatial distribution as demand increases. Water quality problems may limit return flows, depending on the interactions of EPA regulations with economically achievable extents of treatment.

Ground water chemical quality problems will be an important issue in the future in relation to municipal water supplies. Minor problems will also occur in connection with agricultural, mining, energy, and manufacturing uses.

Related Land Issues

Flooding occurs occasionally in the problem area as the result of winter rain, spring snowmelt, and high intensity summer thunderstorms. Many of the communities and settlements have been subject to flooding, as have many of the ranches in the area. Flooding is expected to continue as a major issue in the future for some of the area's urban centers. Additionally, minor problems will be associated with flooding of crops and interference with fishing and other river, stream, and lake uses.

Problems concerning erosion are expected to adversely affect crops, fishing, and environmental considerations of river, stream, and lake use as well as fish and wildlife habitat.

Evapotranspiration from phreatophytes in a water short area consumes water which could be used for man's productive endeavors, or managed for recreation or fish and wildlife purposes. Environmental and recreational uses of phreatophytes are largely opposed to economic activities which require the control or removal of phreatophytes. Phreatophyte management will continue to be an important issue in the Carson-Truckee river basins problem area for some time in the future.

Institutional and Financial Issues

The most publicized conflict situations in the area involve Pyramid Lake and upstream uses, Lake Tahoe development, sewage disposal, amount and type of future growth, and Federal encroachment. Other issues concern Interior Department rules and regulations for operating the Truckee-Newlands system; Pyramid Lake lawsuit (involving Indian claims); Bureau of Reclamation intention to operate Truckee-Carson Irrigation District and associated lawsuit; Environmental Protection Agency regulations, States' rights versus Federal agencies; delegation of legislative authority; and shortage of capital for governmental and private projects. Private development endeavors for water, gas, and electric energy utilities, agriculture, mining, and recreational and environmental purposes are being forced into high interest rate, short term situations.

Federal ownership of lands in the Carson-Truckee river basins problem area is about 70 percent. Federal-State-private institutional conflicts have developed over a large proportion of the small and isolated private base. Federal and State agencies are increasingly engaged in regulating private activities, and Federal agencies are concurrently competing to enforce their own functions upon withdrawals of the public domain.

Adverse Effects

Problems associated with land ownership and regulation are potentially great because the developed base is large and growing. In some cases the regulatory stance may possibly result in mitigation of problems. However, the long term implications for unresolved problems are far reaching.

Summary

The Great Basin Region includes those parts of Nevada, Utah, and Idaho lying between the Wasatch and Sierra Nevada ranges on the east and west, and the Malheur closed basin and Mojave Desert on the north and south. It encompasses approximately 139,000 square miles. Topographically, the region is characterized by parallel north-south mountain ranges and intervening desert valleys.

Climate within the Great Basin Region is highly variable, largely according to elevation. However, most of the area is semiarid with large expanses receiving eight inches of rain or less annually. Average annual precipitation for the region is about 11 inches, making it one of the most arid regions in the Nation.

The difficult terrain and inhospitable climate made the Great Basin Region the last large portion of the United States to be explored. Settlement began in 1847 with the mass migration of Mormons into the area. Population has since expanded to a 1975 total of 1.3 million persons, about 77 percent of which live in and around Salt Lake City or other portions of subregion 1601.

Originally, settlement of the eastern part of the region was based on an agricultural economy, while western areas were heavily oriented toward a mining economy. Since then, both areas have developed more diversified economies including tourism, manufacturing, and lumbering. Per capita income for the Great Basin Region is about 9 percent below the average for the Nation.

Most of the streamflow in the region originates in the high mountains at its eastern and western edges. The region is almost totally a hydrologically closed basin and all of the rivers and streams eventually end in terminal lakes or sinks where evaporation creates high salinities. The total present average annual outflow for the Great Basin Region is about 2,562 mgd, subject to great variation on a seasonal and yearly basis. Most precipitation occurs as snow deposits from winter storms. Water quality varies from excellent in mountain headwater streams to poor in lower stream reaches and terminal lakes. Principal pollutants are salts, sediment, nutrients, and heat.

Ground water is widely distributed throughout the region and supports most developments located away from the base of the mountains. Recharge rates are low in central parts of the region and significantly greater withdrawals there could result in widespread depletions from storage. The quality of ground water is generally good except under terminal sinks where it tends to be saline.

Water withdrawals from ground and surface sources are made for a wide variety of purposes, with irrigation by far the largest accounting for about 87 percent of all withdrawals from all sources. Total withdrawals

were about 7,991 mgd in 1975 but are expected to be reduced to about 7,253 mgd by 2000 as irrigation efficiencies increase and greater reuse is made of withdrawn waters.

Land resources in the Great Basin are large but are limited for agricultural purposes by the availability of water. About three-fourths of the land is administered by the Federal Government. Only about 2 percent of the region's land is irrigated; 70 percent is pasture and rangeland, most with fairly low productivity. Most irrigated areas and urban areas are located on the eastern or western borders of the region where water supplies originate.

Mineral production in the Great Basin Region includes copper, molybdenum, gold, iron ore, and numerous other metallics and nonmetallics. Copper accounts for over one-half of all mineral production.

The large majority of energy produced in the region in 1975 was from fossil-fueled steam electric facilities with the remainder furnished by hydroelectric plants. Energy production is expected to increase greatly by the year 2000, with future production dominated by nuclear plants according to NF projections, and by conventional plants according to SRF projections.

Environmental resources in the Great Basin Region are diversified and support a wide range of recreational activities. In addition to large expanses of land varying from mountains to deserts, over a million acres of water surface are available for use. Wildlife includes big game, upland birds, small mammals, and waterfowl as well as a wide variety of fish. There are numerous wildlife refuges and management areas, parks, monuments, and forests. The region also contains 60 miles of streams in subregion 1601 which are nationally significant for fish and wildlife purposes.

Flooding is a serious and widespread problem in the region. Average annual damages were estimated to be $10.0 million in 1975 and are expected to increase about 37 percent by 2000. Damage is caused by varying lake levels as well as riverine floods.

The scarcity of water in the region generates competition for its use and for land that is well located with respect to water. In several areas lack of water is impeding further economic development, and urbanization of agricultural lands is causing conflicts.

Most of the important water-related issues in the area concern State and local institutional and financial arrangements and require non-Federal action for resolution. Federal assistance is required primarily in flood control, new irrigation water supplies, and in financing water quality management measures.

Ten areas which together constitute most of the region have been identified as having special problems: the Bear, Weber-Davis, Jordan, Sevier-Beaver, Snake, Humboldt, Walker and Carson-Truckee river basins; The Great Salt Lake; and the Central Region area.

Conclusions and Recommendations

Conclusions

The Great Basin, for the foreseeable future, will be required to meet increased water demand with the supply physically available in the area. The manageable water supply is not a fixed quantity, but is dependent upon law, economics, and technology, as well as hydrologic variability. However, there are limits to the effectiveness of law, economics, and technology in attempting to change management of the amount of water available for use.

Increased population and economic activity will exert added pressure on the existing water supply in the Great Basin Region and, in areas where demand nears or equals surface supply, future measures will include almost all of the following:

Additional surface water development;

Additional ground water development;

Increased water conservation and reuse;

Possible limitations on further appropriation and development of water supplies;

Transfers between adjacent small basins or importation involving large regions; and

Possible precipitation increase through atmospheric management.

Because most water-related problems in the Great Basin Region are amenable to State and local solution and because authorities closer to the grass roots level generally have a better grasp of changing attitudes and how best to deal with them, it appears logical to allow each State to work internally to solve as many of its problems as possible.

Many of the institutional problems in the Great Basin Region are associated with the extensive Federal ownership of land which ranges up to 96 percent of individual subregions. Federal-State-private insitutional conflicts have developed over a high proportion of the small and isolated private base. Federal and State agencies are increasingly engaged in regulating private activities. Federal agencies are concurrently concerned about carrying out their own functions under mandates of individual diverse laws upon withdrawals of the public domain.

A major stumbling block in water planning is the inability to forecast the future with reasonable accuracy. Changing political, social, and economic factors intensify this problem. Significant improvements in methodology are needed to increase the reliability of both long-term general projections and short-term detailed projections.

It is believed that the system of allocating water through State water laws has worked well generally in the Great Basin Region. Desirable changes have been effectuated gradually over a period of 100 years. Any proposed modifications affecting State water laws would probably engender considerable resistance.

Most of the water related problems in the Great Basin Region are unsolved because of shortage of water supply and political, institutional, legal, or financial constraints. The Great Basin has been studied in considerable depth (e.g., 1968 National Assessment, Water Resouces Council Framework Study, Western U.S. Water Plan, and State Water Plans). The need now is for implementation of the courses of action that have been recommended as an end result of previous studies.

Recent Federal legislation for controlling detrimental impacts upon the environment has effects far wider than may have been anticipated.

Flooding is a widespread problem in both urban and rural areas of the Great Basin Region.

Recommendations

The following recommendations have been developed by the Regional Sponsor and are presented to show the viewpoints of officials of the States of Nevada and Utah.

Federal Role

Federal agencies should be more helpful and productive in finding solutions to water and land resource problems by restricting their activities to areas where States have been unable to reach agreement or to cases where States request assistance. The presented authorized federally adjusted water supply and flood control projects should be completed.

The Congress should amend the deadlines and target levels in Federal Water Pollution Control Act Amendments of 1972, the Safe Drinking Water Act, the Endangered Species Act, and the National Environmental Policy Act of 1969, to more realistically take into account economic and social effects.

State water laws and water rights should be recognized by the Federal Government.

Planning

No additional regional or large scale river basin planning studies should be made in the Great Basin Region, since there is no need for additional multiobjective, multidisciplinary studies of the Level B type at the present time.

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[1] The Washington staff of the Federal agencies was augmented by field office staff who participated with Washington offices or through the Regional Study Teams
[2] Several States had representatives on more than one Regional Study Team Contributions of those not named were greatly appreciated

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Authorization

The United States Water Resources Council was established by the Water Resources Planning Act of 1965 (Public Law 89-80). The purpose of the Council is to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the Federal government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, States, local government, individual corporations, business enterprises, and others concerned.