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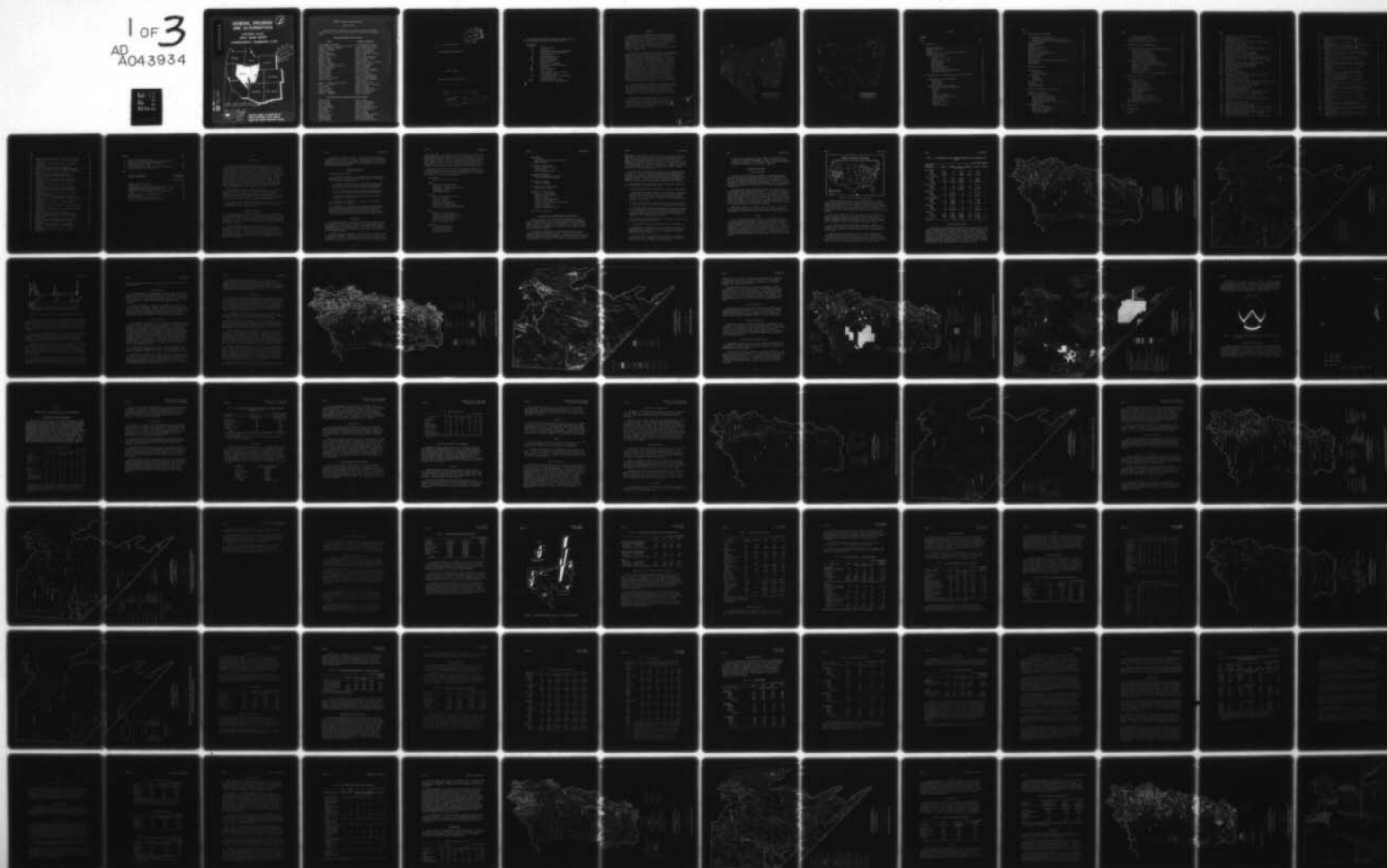

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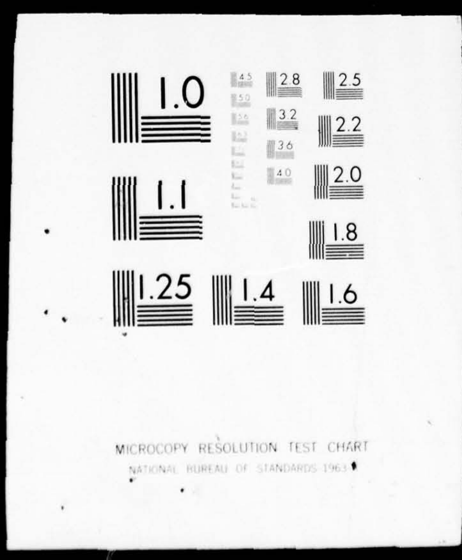
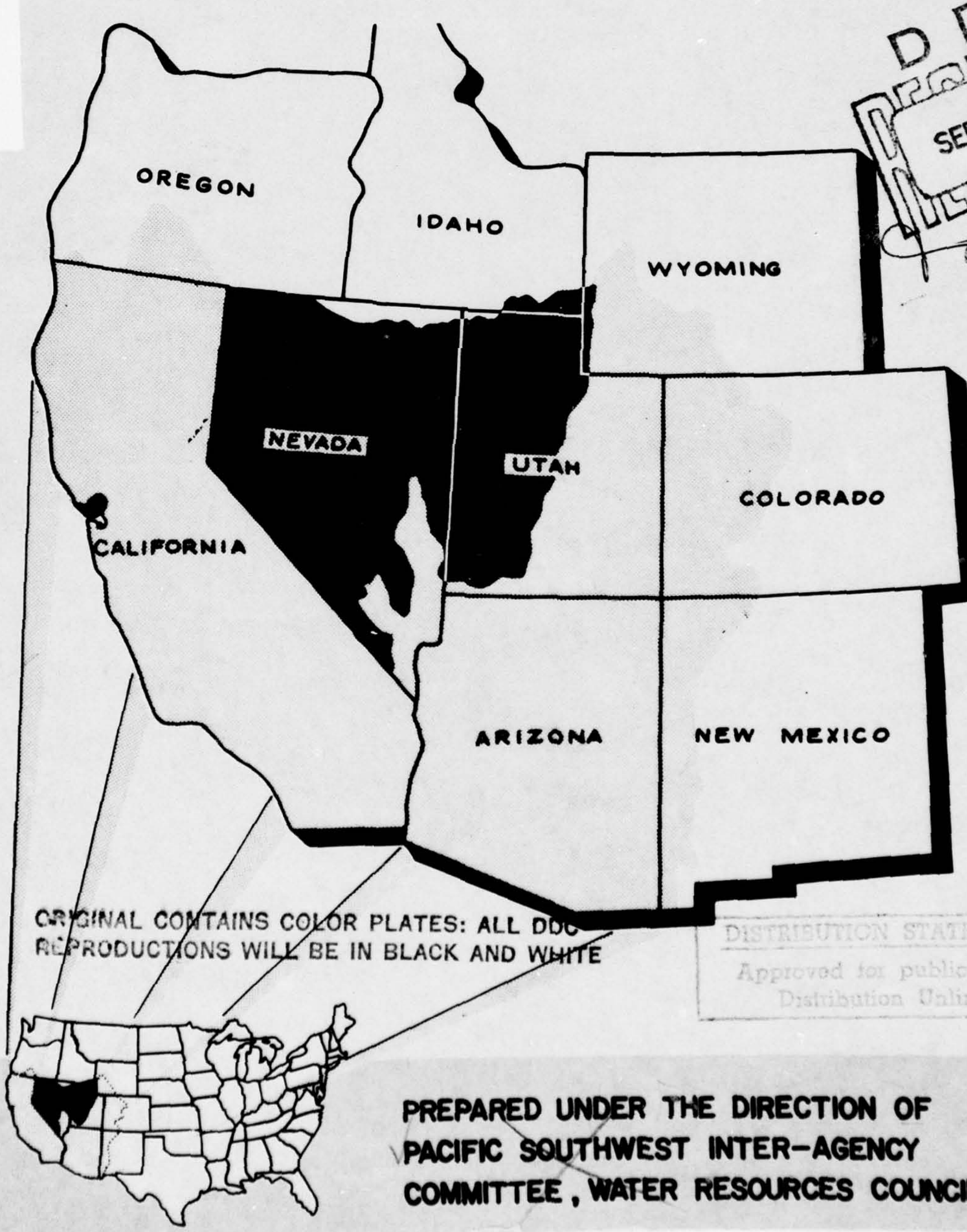


GENERAL PROGRAM AND ALTERNATIVES

APPENDIX XVIII
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK STUDY



PREPARED UNDER THE DIRECTION OF
PACIFIC SOUTHWEST INTER-AGENCY
COMMITTEE, WATER RESOURCES COUNCIL

GENERAL PROGRAM AND ALTERNATIVES

Appendix XVIII

This appendix was prepared by the General Programs and Alternatives Work Group of the Great Basin Region State-Federal Interagency Group.

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(6) GREAT BASIN REGION

COMPREHENSIVE FRAMEWORK STUDY.

APPENDIX XVIII.

GENERAL PROGRAM AND ALTERNATIVES,

(11) JUN 1971

(12) 218p.

The following publications have been prepared under the Great Basin Region Comprehensive Framework Study:

Main Report

Appendixes

I	History of Study
II	The Region
III	Legal and Institutional Environments
IV	Economic Base and Projections
V	Water Resources
VI	Land Resources and Use
VII	Mineral Resources
VIII	Watershed Management
IX	Flood Control
X	Irrigation and Drainage
XI	Municipal and Industrial Water
XII	Recreation
XIII	Fish and Wildlife
XIV	Electric Power
XV	Water Quality, Pollution Control and Health Factors
XVI	Shoreline Protection and Development (not applicable)
XVII	Navigation (not applicable)
XVIII	General Program and Alternatives

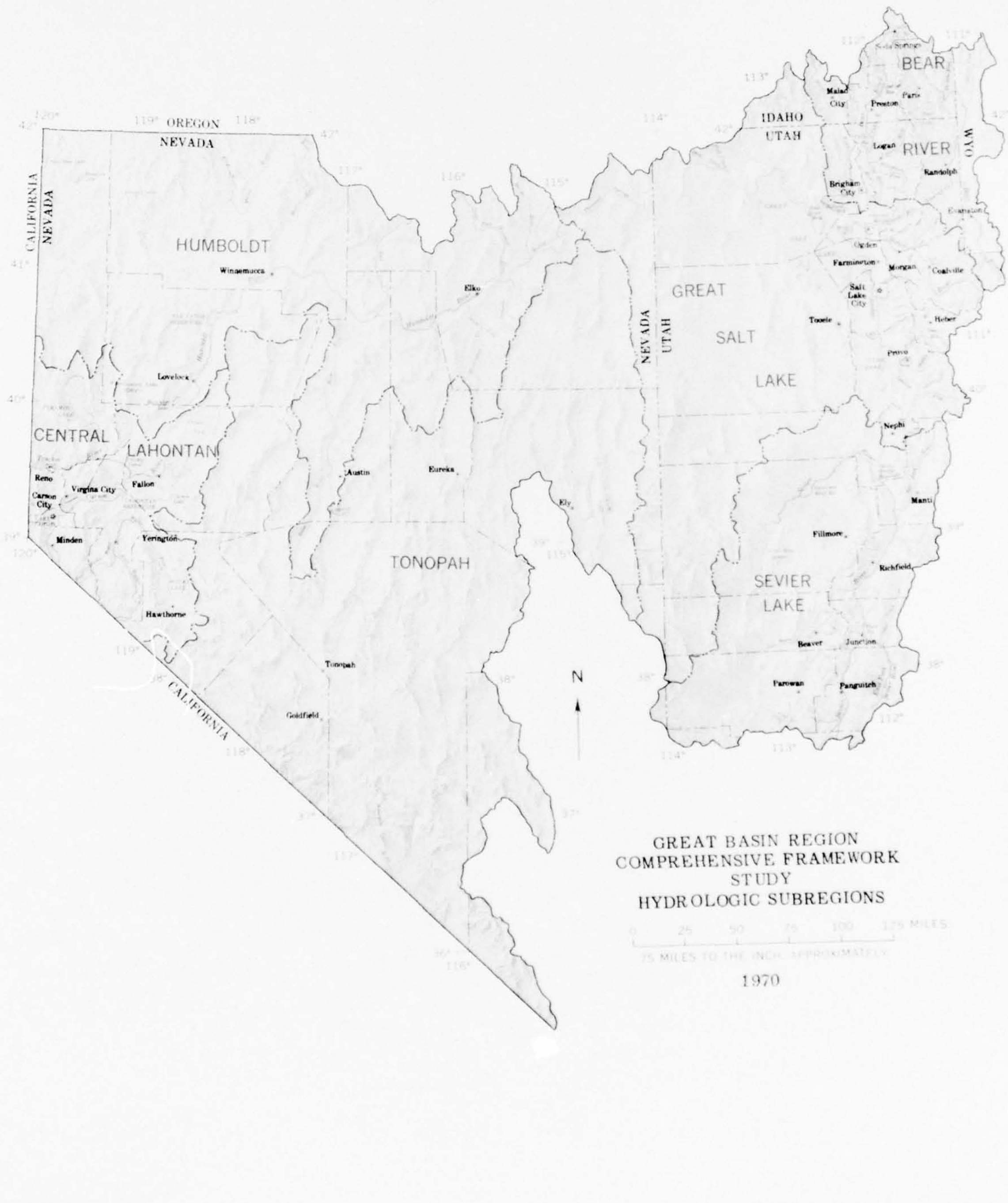
FOREWORD

This report of the Great Basin Region State-Federal Interagency Group was prepared at field level and presents a framework program for the development and management of the water and related land resources of the Great Basin Region. This report is subject to review by the interested federal agencies at the departmental level, by the Governors of the affected states, and by the Water Resources Council prior to its transmittal to the Congress for its consideration.

This report is prepared in accordance with guidelines, objectives and projections set forth by the Water Resources Council which is directing a national effort toward regional comprehensive framework planning. It includes the main report and 16 supporting appendixes. Estimated requirements for water and related land resources within the Region are based on an assigned portion of a set of national projections of March 1968 developed by the Office of Business Economics, U.S. Department of Commerce and Economic Research Service, U.S. Department of Agriculture. This study evaluates the adequacy of water and related land resources in the Great Basin Region to meet these projected requirements through selected time frames to 2020. The resultant program considered with framework plans of the other Regions, permits a general evaluation of the national capacity to meet projected requirements for water and related land resources for the next 50 years.

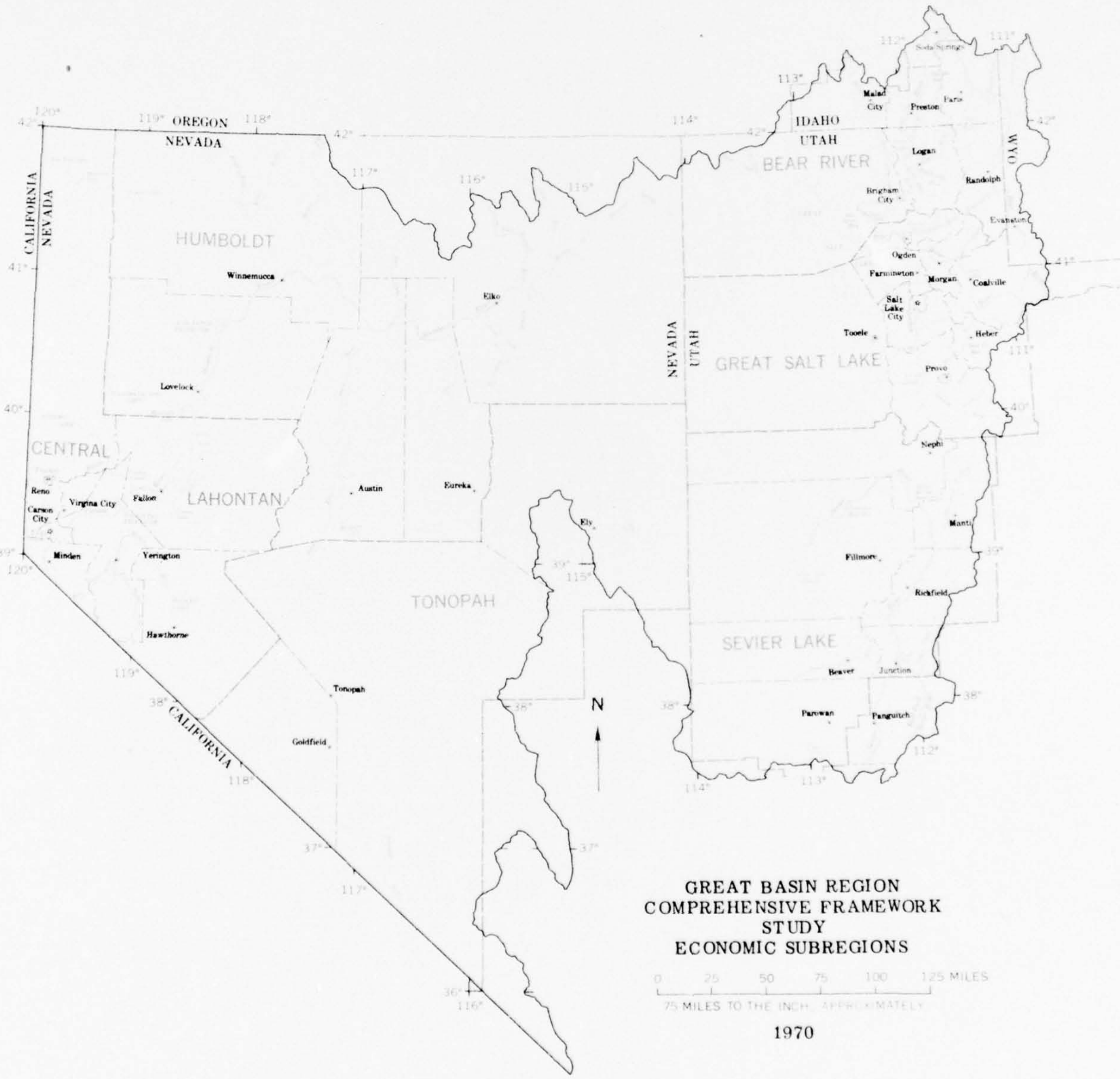
The plan represents a concept--an illustration of one way to meet the coming needs and the kinds of problems that are involved. Developments of specific projects under this or other comprehensive plans would require more detailed studies. The plan does not necessarily reflect the programs or viewpoints of any federal or state agency.

The several states are currently in various stages of preparation of state water plans. The completed state water plans undoubtedly could reflect significant differences from this framework plan due to differences in projections and their translation into the needs for water and related land resources.



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
HYDROLOGIC SUBREGIONS

1970



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
ECONOMIC SUBREGIONS

1970

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PART I

INTRODUCTION

The General Program and Alternatives Appendix is a part of the Great Basin Region Comprehensive Framework Study report. The purpose of this appendix is to bring together the pertinent facts from the various individual appendixes so that a comprehensive framework plan can be formulated. This plan is the coordinated result of the efforts of participants from various federal and state agencies. Changes are made from the projections of some appendixes in order to bring the individual needs or demands to areas of available supply. In some cases, substitutions are made for specific types of demands. The plan provides one means of meeting, in general, the projected needs of this Region to the year 2020. Other solutions having different basic assumptions may be equally satisfactory. This appendix also presents alternatives to some segments of the plan.

Although not the primary intention of this appendix, in performing the above function, this does become a summary of the other appendixes. It is intended that sufficient basic information be brought from the individual appendixes into Appendix XVIII so it can stand alone as a complete document. Details which explain and support this basic information remain in the individual appendixes.

The plan has been formulated with regard to the water laws of the affected states. These laws, in general, are based on the principle of appropriated rights for beneficial use.

National Objectives

The overriding determinant in considering the best use of water and related land resources is the common good of all the people. Hardship and basic needs of particular groups within the general public are of concern, but care is taken to avoid resource use and development for the benefit of a few. Policy requirements and guides established by the Congress are observed.

Proper stewardship requires that resources be protected and rehabilitated to insure availability for their best use when needed. Open space, green space, and wild areas should be maintained for recreational purposes. Areas of unique natural beauty and historical and scientific interest should be preserved and managed and the Region should remain, insofar as possible, a spacious, uncrowded land for the enjoyment of the people.

Economic development is needed to maintain national strength and achieve satisfactory levels of living. Full consideration is given to development, conservation of resources and well-being of people. Water and related land resources development and management are essential to economic development and growth.

Regional Objectives

The major objectives are:

1. To appraise the ability of the Region to provide goods and services to meet the projected needs and demands of its people to 2020, including determination of:

   a. Amount of goods and services that can be produced and the economic level that can be achieved with development and efficient use of water and related land resources.

   b. The adequacy of resources to meet projected needs and the extent of residual water and related land resources.

   c. The nature and amount of deficiencies and economic capability to overcome them.

2. To appraise the capability of the Region to contribute to the well-being of the Nation.

3. To appraise the characteristics of water and related land resources problems, outline general approaches appropriate to their solution, estimate effects of alternative solutions, determine social and environmental impacts and, where conflicts occur, make reasonable choices based on the knowledge at hand.

Authority

The Great Basin Region is one of 20 in the United States included in a nationwide program of comprehensive river basin planning for development, use and management of water and related land resources. This program stems from recommendations of the Senate Select Committee on National Water Resources, which were presented by the President in the 1963 Budget Message.

The Water Resources Planning Act (P.L. 89-80, July 22, 1965) gave the President authority to organize the Water Resources Council. He transferred the functions and organizational procedure employed by the Interagency Committee on Water Resources to the Water Resources Council on April 10, 1966. On November 21, 1966 the Pacific Southwest Interagency Committee accepted responsibility and leadership for the comprehensive framework studies in the Pacific Southwest as requested by the Water Resources Council. An organizational meeting was held May 3, 1968 and funds were made available to begin the Great Basin Region study in fiscal year 1969. The States of Utah and Nevada were subsequently designated as chair agencies to direct study efforts.

The states of Nevada, Idaho, Utah, Wyoming and California and interstate compact commissions within the Region are participating in this investigation with the various federal agencies. The following list indicates participating organizations:

California
- Department of Water Resources

Idaho
- Bureau of Mines and Geology
- Department of Fish and Game
- Department of Health and Sanitation
- Department of Parks
- Water Resources Board

Nevada
- Bureau of Environmental Health
- Division of Forestry
- Division of Parks
- Division of Water Resources
- Fish and Game Commission
- State Soil Conservation Committee
- University of Nevada, School of Mines

Utah
- Division of Fish and Game
- Division of Parks and Recreation
- Division of Water Resources
- Geological and Mineralogical Survey
- Office of Attorney General
- State Health Department

Wyoming
- Fish and Game Commission
- Recreation Commission
- State Engineer's Office
- State Health Department

Commissions
- Bear River
- California-Nevada Interstate Compact
- Upper Colorado

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation Service

Department of Commerce
- National Weather Service, NOAA
- Office of Business Economics

Department of Defense
- Corps of Engineers

Environmental Protection Agency
- Water Quality Office

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Bureau of Sport Fisheries and Wildlife
- Geological Survey
- National Park Service
- Office of Regional Solicitor

Federal Power Commission

Planning Policies, Procedures, and Constraints

Planning policies for the Great Basin Comprehensive Framework Study were established by the Great Basin State-Federal Interagency Group cochaired by the States of Utah and Nevada. The Great Basin Staff, chaired by the Department of Agriculture and composed of state and federal agency personnel, is responsible for utilizing available data to complete the study.

The projected requirements of the Great Basin Region include assigned portions of the national needs. The Office of Business Economics (OBE), Department of Commerce, provided present and projected data for population, total employment, gross national product, personal income and per capita income. The Economic Research Service (ERS), Department of Agriculture, provided data for agricultural sectors of the economy. The combined projections have been designated as "OBE-ERS". The OBE-ERS projections were derived to provide a guide in evaluating the national capacity to meet the total future needs. This appendix is designed to assess the capacity of this Region to produce its assigned share of the national requirements. These projections may not reflect actual requirements, or represent the future economic conditions of the Great Basin Region.

The year 1965 was adopted as the base year for purposes of plan formulation. All projects developed during the period 1965-1970 or funded by July 1968 are considered available to meet 1980 demands. Data were limited to those which could be compiled and evaluated from existing sources. Decisions were made by consensus and judgment of experienced planners, reflecting the cooperation of those involved.

The appendixes listed on the back of the title page contain the basic material used to prepare this report.

The following assumptions and guidelines are basic to the study:

1. Water now beneficially used will not be diverted to supplement growing urban or industrial demands, except where this growth occupies land on which water is beneficially used for another purpose. In this case, the water supply will be transferred with the land to the new use.

2. Allocation of developed water supplies will be predicated on the projected demands for commodities, services and other purposes.

3. Available water allocated under compacts, agreements, or laws but not presently used within the defined duty would be available for future beneficial use of the appropriate organizational unit. Appropriate state laws or policies are inherent in determining priorities among competing areas and uses.

4. The ocean is considered available to the Region as a new source of water by exchange or direct use.

5. Cost-repayment capacity relationships are not considered.

6. Maintenance of environmental quality deserves high priority. Planning must give cognizance to all resources for a pattern of future development which will preserve or enhance the esthetic and health-related attributes.

7. The terms used in this document are defined in the glossary. Material used in this appendix is adapted from other appendixes, and references are cited there, where applicable.

8. Most of the subregional data throughout the report are presented for the hydrologic subregion. Tabular material referring to economic subregions is specifically noted. Most data regarding economics and minerals are for economic subregions.

Regional Description

Location and Size

The Great Basin physiographic province is a 188,000-square-mile area having no outlet to the sea, formed as a great irregular bowl generally centering on Nevada and western Utah. The boundary of this basin is not completely defined by mountain ranges and thus it can be described as that area enclosed, but not drained, by the Colorado River Drainage, the Columbia River Drainage, and the westward drainage of the Sierra Nevada.

The Great Basin Region study area excludes those parts of the physiographic basin in Oregon and California. It includes about 80 percent of Nevada, the western half of Utah, a small part of southeastern Idaho and the southwestern corner of Wyoming. The Region, of approximately 136,700 square miles, has been divided into six hydrologic subregions, as shown on the frontispiece map. Figure 1 shows the relationship of this Region to the rest of the contiguous United States. The parts of the Great Basin not included in this study region are shown by the outline extending into Oregon and California.

The Region contains 87.5 million acres of which 85.7 million is land area and 1.8 million is water surface area. Table 1 shows the distribution of land and water area by hydrologic subregions and states.

Climate

The climate varies widely as a result of large differences in elevation, an appreciable range in latitude and irregular distribution of mountain ranges and highlands. Generally this climate is semiarid with precipitation in the lower valleys ranging from 3 to 5 inches annually in the rain shadow of the Sierra Nevada and in the Great Salt Lake Desert. In northern valleys, the annual precipitation is about 15 inches with accumulations up to 60 inches in the higher elevations. Average annual precipitation is shown on maps following page 8. Figure 2 shows the general elevation and precipitation relationship across the basin.

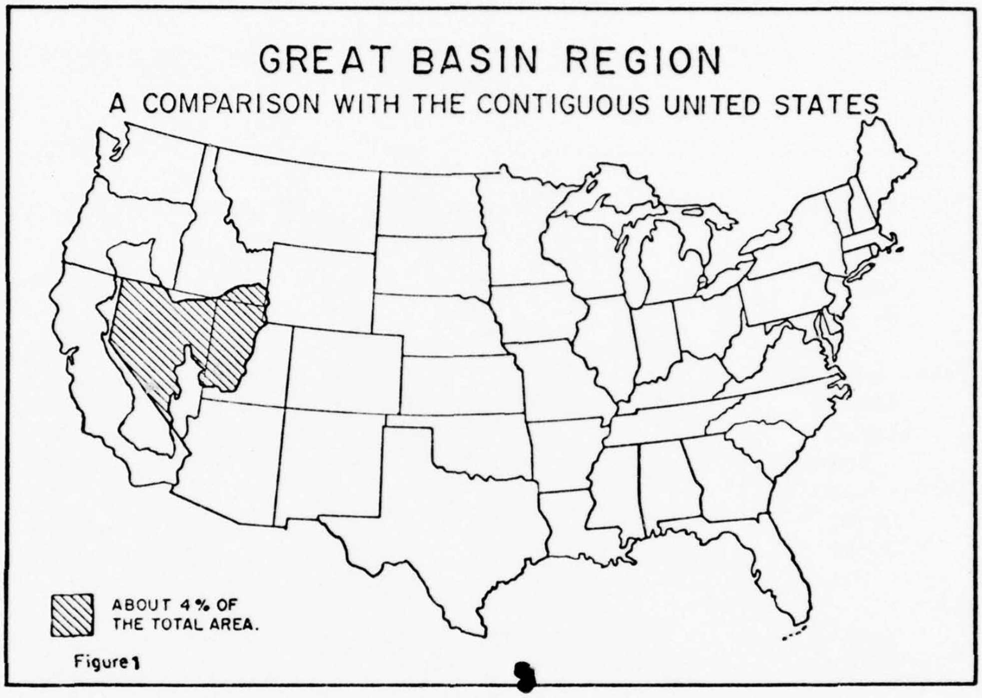


Figure 1. Location Great Basin Region

Widely fluctuating temperatures are characteristic of semiarid areas, with definite variations according to altitude and latitude. Average temperatures range from 60 degrees F. in the extreme southern portion to 30 degrees F. in some of the high northern valleys. Average daily changes are in excess of 30 degrees in most of the valleys. Variations in excess of 50 degrees are common in some valleys of western Nevada.

The relative humidity is low, averaging about 35 percent in the north and central sections and 20 percent in the extreme south. Low humidity, abundant sunshine, and light to moderate winds account for annual evaporation losses exceeding 100 inches in the south and about half that amount in most of the northern and central valleys.

The average frost-free period ranges from about 200 days in the extreme south to less than 20 days above 9,000 feet in the northern mountains. The average in major agricultural areas varies between 100 and 175 days.

Sunny days prevail throughout most of the year averaging about 75 percent in the south and 70 percent in the north. High pressure cells tend to settle over the area during late fall and winter causing fog to form when the moisture content of the air is high. The average number of days for this condition varies from 5 to 10 each year.

TABLE 1. DISTRIBUTION OF TOTAL LAND AND WATER AREA BY SUBREGION AND STATE

Great Basin Region

Hydrologic subregion	Idaho	Nevada	Utah	Wyoming	Total	Percent
			(1,000 acres)			
Bear River						
Land	1,682	0	2,042	957	4,681	
Water	43	0	50	2	95	
Total	1,725	0	2,092	959	4,776	6
Great Salt Lake						
Land	446	2,438	14,311	5	17,200	
Water	0	0	1,329	0	1,329	
Total	446	2,438	15,640	5	18,529	21
Sevier Lake						
Land	0	70	10,247	0	10,317	
Water	0	0	41	0	41	
Total	0	70	10,288	0	10,358	12
Humboldt						
Land	0	19,104	0	0	19,104	
Water	0	37	0	0	37	
Total	0	19,141	0	0	19,141	22
Central Lahontan						
Land	0	6,059	0	0	6,059	
Water	0	240	0	0	240	
Total	0	6,299	0	0	6,299	7
Tonopah						
Land	0	28,356	0	0	28,356	
Water	0	3	0	0	3	
Total	0	28,359	0	0	28,359	32
Region						
Land	2,128	56,027	26,600	962	85,717	
Water	43	280	1,420	2	1,745	
Total	2,171	56,307	28,020	964	87,462	100
Percent	3	64	32	1	100	

Land Forms and Geology

The interior of the Great Basin Region is characterized by parallel mountain ranges separated by broad desert basins. These generally trend north to northeast with straight or gently curved crests. Commonly, the ranges are 40 to 80 miles long and 5 to 15 miles wide and are spaced about 15 to 25 miles apart. Typically, the crests are 3,000 to 5,000 feet above the floors of adjacent valleys. Substantial segments of the crests are more than 10,000 feet above sea level in central and eastern Nevada and along the eastern boundary of the Region in Utah. Elsewhere the altitude of the crests generally is less than 9,000 feet.


BEAR
RIVER
GREAT
SALT
LAKE
GREAT
SALT
LAKE
SEVIER
LAKE
UTAH
LAKE
IDAHO
UTAH
WYOMING
UTAH
NEVADA
UTAH
Bear River
Bear Lake
Soda Pt Res
Thomas Fk
Smiths Fork
Malad
Oneida Res
Cub R
Cutler Res
Logan
Little Bear River
Blacksmith Fork
Woodruff Cr
Willard Bay
Bear River Bay
Pineview Res
Ogden River
Weber R
Lost Creek
Echo Res
Jordan R
Provo R
Deer Cr Res
Hobble Cr
Spanish Fork
Sevier River
Sevier Bridge Reservoir
San Pitch River
Gunnison Bend Res
Pine Creek
Dove Creek
Thousand Springs Cr
115°
114°
113°
112°
111°
42°
41°
40°
39°

EXPLANATION

NOTE: Lines of equal precipitation in inches are from: ESSA Weather Bureau maps for Idaho, Utah, and Wyoming and adapted from the Hardman precipitation (Rev. 1965) for Nevada. Lines were adjusted to provide smooth curves across state lines where appropriate. Precipitation lines are considered to represent 1931-60 normals for Utah, and to approximate 1931-60 average conditions for the other states.

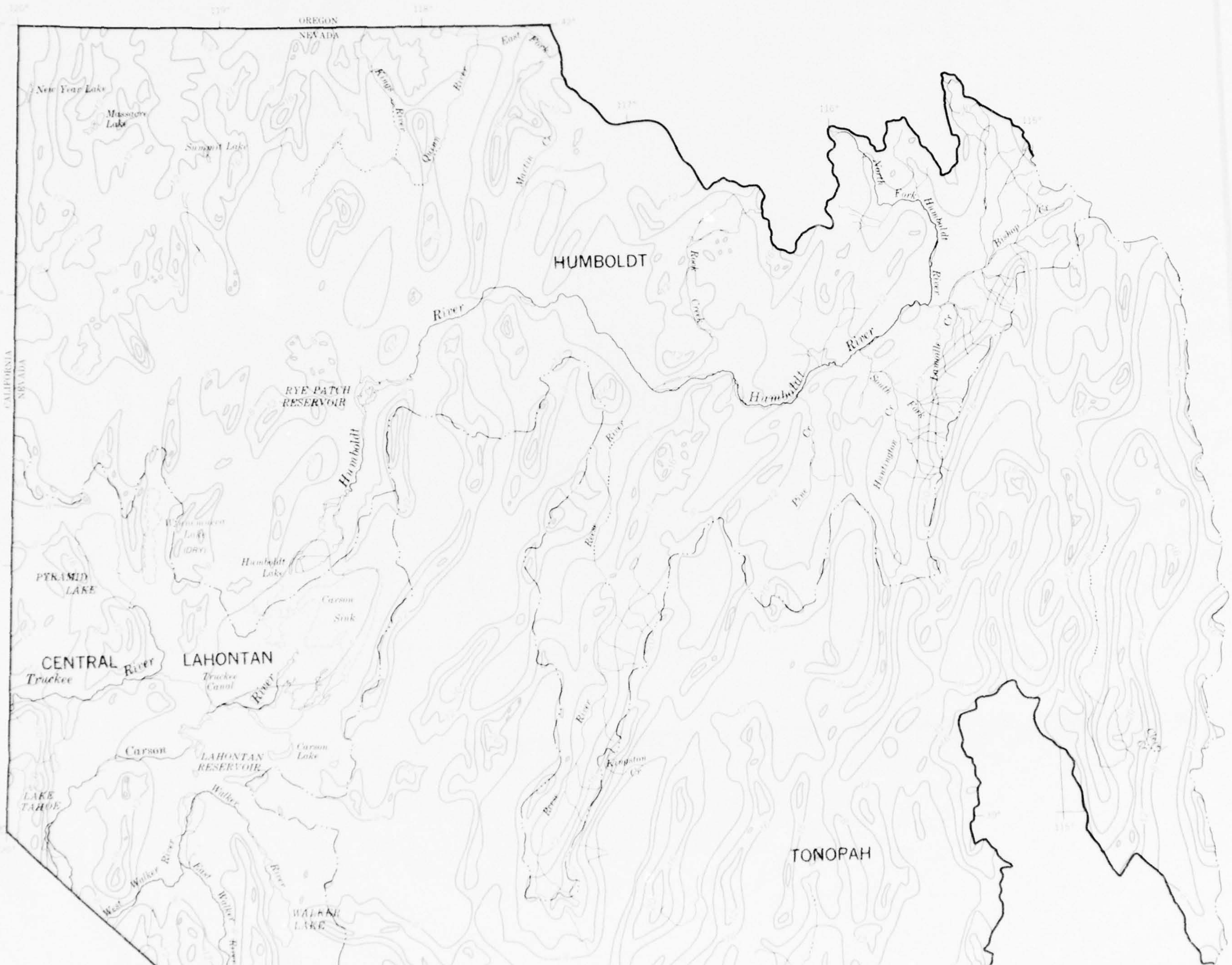
Boundary of hydrologic subregions

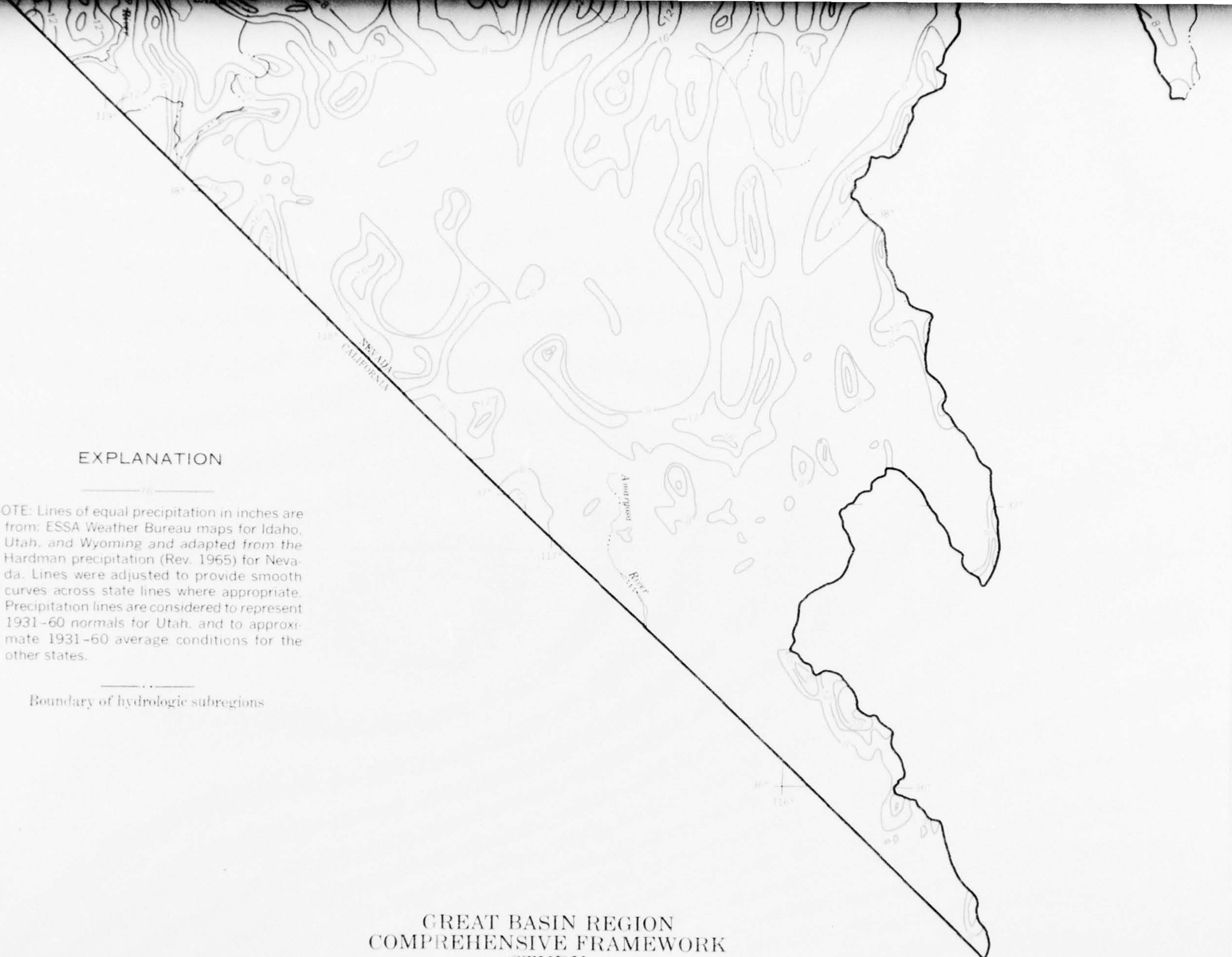
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

32 MILES TO THE INCH, APPROXIMATELY

1970

AVERAGE ANNUAL PRECIPITATION


OREGON
NEVADA
CALIFORNIA
NEVADA
New Year Lake
Massacre Lake
Summit Lake
Kings River
Quinn River
East Fork
Martin Cr.
HUMBOLDT
Rock Creek
North Fork Humboldt River
Bishop Cr.
Humboldt River
Lamoille Cr.
South Fork
Huntington Cr.
Pine Cr.
RYE PATCH RESERVOIR
Humboldt
Reese River
Kingston Cr.
Humboldt Lake
PYRAMID LAKE
Carson Sink
CENTRAL
LAHONTAN
Truckee River
Truckee Canal
Carson River
LAHONTAN RESERVOIR
Carson Lake
LAKE TAHOE
Walker River
West Walker River
East Walker River
WALKER LAKE
TONOPAH



EXPLANATION

NOTE: Lines of equal precipitation in inches are from: ESSA Weather Bureau maps for Idaho, Utah, and Wyoming and adapted from the Hardman precipitation (Rev. 1965) for Nevada. Lines were adjusted to provide smooth curves across state lines where appropriate. Precipitation lines are considered to represent 1931-60 normals for Utah, and to approximate 1931-60 average conditions for the other states.

Boundary of hydrologic subregions

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

AVERAGE ANNUAL PRECIPITATION

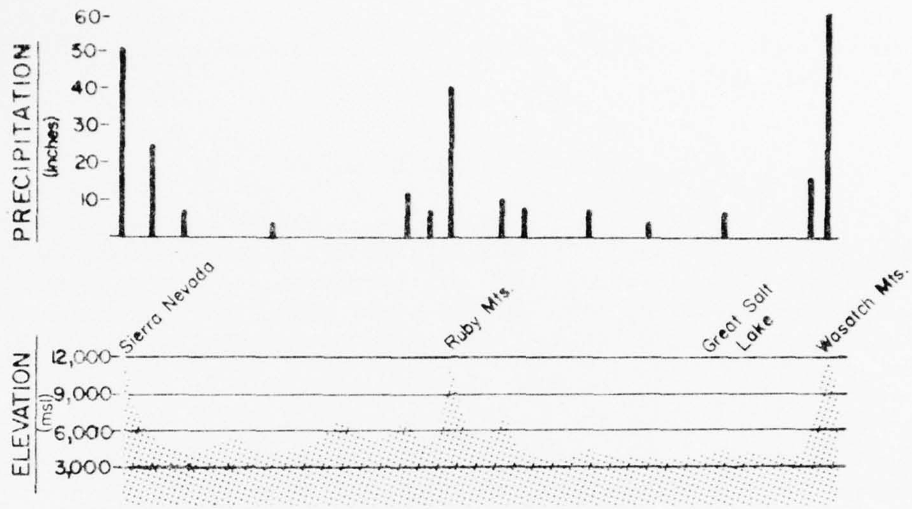


Figure 2. General relationship of elevation and precipitation.

The Region is bordered on the east by sedimentary and associated volcanic and intrusive rocks of the Wasatch Range and the High Plateaus. The granitic rocks of the Sierra Nevada and spur ranges mark the western border. Thick lava flows along the south side of the Snake River Drainage form the northern boundary, and the southern border is made up largely of sedimentary rocks, which are dissected by the Colorado River drainage.

The present-day landscape is the result of many geologic processes. Faulting and folding of great intensity and complexity have occurred. Periods of erosion have subdued highlands and filled lowlands with sediment. These alternating processes of sedimentation, mountain building, and erosion have occurred repeatedly and at various times.

Shoreline and beach features, common in some segments of the basin, were formed by prehistoric lakes which covered large areas. The largest were Lake Bonneville, which occupied about 20,000 square miles of western Utah, and Lake Lahontan, which occupied more than 8,000 square miles in western Nevada. Great Salt Lake and Utah Lake are present day remnants of Lake Bonneville, and Pyramid and Walker Lakes are remnants of Lake Lahontan.

Great mineral wealth has been and is being extracted from the older rocks in the mountains and unknown wealth still remains concealed. The alluvium, which occupies more than half the total area, is the principal source of ground water for irrigation, industrial, and municipal uses;

however, at the present, surface streams provide most of the water for these purposes.

Terminal Lakes

The Great Basin is a hydrologically closed drainage consisting of many smaller closed basins making terminal lakes or sinks distinctive features. 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.

Residual streamflow is received in terminal sinks from which the water is finally evaporated. Terminal lakes become more saline with time since the salts remain as water evaporates. As upstream depletions increase, upsetting the balance of inflow and evaporation, salinity of the terminal lakes increases and the water levels drop. Terminal lakes satisfy many uses including fish and wildlife, and recreation.

Water Resources

The Great Basin Region is the most arid of the Comprehensive Framework Study Regions. The average annual precipitation is about 11 inches and most of it is consumed in place by vegetation or returned to the atmosphere by evaporation. The total nominal surface water supply, including natural ground-water discharge, is approximately 10 million acre-feet (MAF) annually. Gaged streamflow is about 2.9 MAF including 1.1 MAF inflow from the California Region. Depletions above gaging stations are about 3.0 MAF. Secondary streams contribute about 1.2 MAF and minor streams on the order of 0.2 MAF. Natural ground-water discharge is about 2.3 MAF annually. Total ground water stored in the upper 100 feet of saturated deposits is estimated to be nearly 200 MAF which, if depleted over a period of 50 years, would yield an annual rate of about 4 MAF per year.

The principal rivers are Bear, Weber, Jordan, and Sevier in the eastern subregions and Humboldt, Truckee, Carson, and Walker in the western subregions. These rivers all flow into terminal sinks or lakes.

Streamflow is seasonally distributed. Unregulated streams commonly discharge 50 to 80 percent of their annual flow in a three-month period starting in April or May. Present usable water storage capacity of lakes, ponds, and reservoirs totals approximately 4.3 million acre-feet. The natural ground-water discharge from 154 separate areas is largely by evapotranspiration of shallow ground water.

The availability of water is limited or constrained not only by physical conditions but also by other factors including laws, administrative or institutional regulations, and economics. Normally streamflow quality remains fairly good throughout most of the length of streams except where there have been extensive irrigation diversions and successive reuse of return flows.

Land Resources

Soils of the Region can be divided into three categories. These are: (1) soils of the mountain slopes which are commonly shallow over bedrock with loam or sandy loam textures and often stony or cobbly; (2) mountain valley soils which are extremely variable, ranging from clays to gravelly or stony sandy loams; and (3) soils on the valley floors and adjacent alluvial fans and lake terraces grading from clay loam to loam on the lower alluvial fans to sandy loam and gravelly soils on the higher and steeper slopes.

Nine vegetal cover types grow on 90 percent of the land in the Region as shown on the vegetal cover maps following page 11. These are grouped into three broad categories: alpine, forest and range.

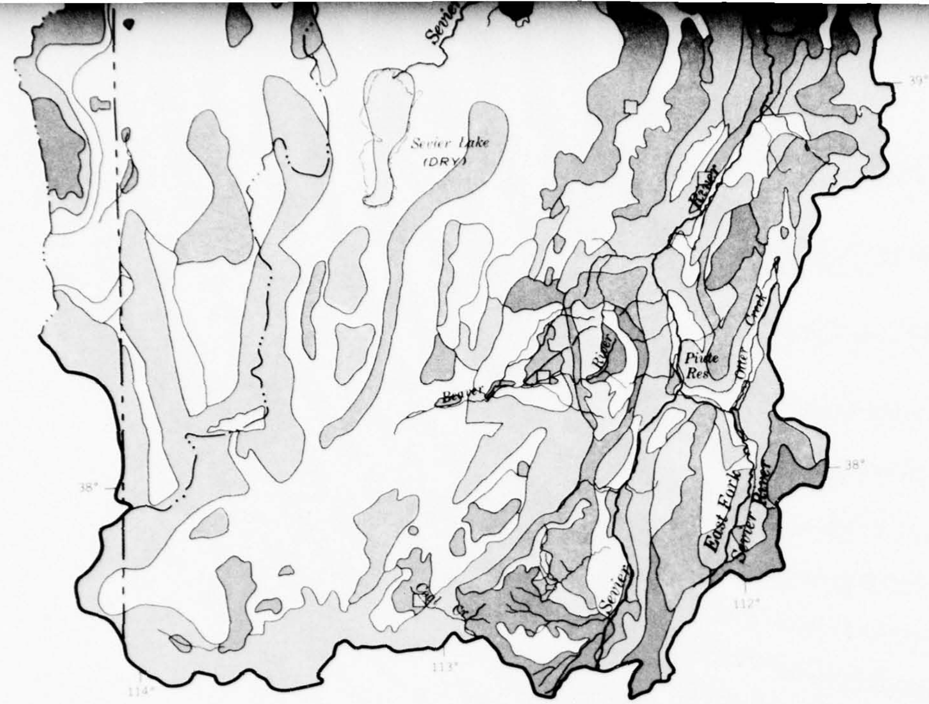
Alpine areas, about 0.3 percent of the total land area, are the uppermost peaks, mountain ridges and glaciated basins with generally sparse vegetation, consisting of sedges, forbs, and low browse plants. These areas receive from 40 to 60 inches of precipitation and are the headwaters of the major streams in the Region.

Forested areas cover about 20 percent of the total land. About 14 percent of this category is coniferous or hardwood type commonly associated with the nomenclature of forest. These types usually grow in higher mountain areas where precipitation ranges from 28 to 40 inches annually. About 24 percent is mountain shrub types, principally on rolling uplands and steep mountain slopes where annual precipitation is from 15 to 26 inches. The remaining 62 percent is pinyon-juniper types where annual precipitation ranges from 12 to 18 inches.

The range category, about 70 percent of the Region, is primarily northern desert shrub and salt desert shrub. About 3 percent of this group is grasses and forbs growing where annual precipitation ranges from 4 to 40 inches. About 4 percent is southern desert shrub with an annual precipitation range from 2 to 8 inches. The remaining 93 percent is divided almost evenly between the northern desert shrub where annual precipitation ranges from 8 to 15 inches and salt desert shrub where annual precipitation ranges from 4 to 8 inches.

The remaining 10 percent of the land in the Region includes barren, urban and commercial use, such as roads and rights-of-way, irrigated

Soda Pt Res
Smiths Fork
Thomas Fk
Malad
Oneida Res
Bear River
IDAHO
UTAH
Bear Lake
BEAR
RIVER
Cub R
Cutler Res
River
Logan
Little Bear River
Blacksmith Fork
Woodruff Cr
Bear
Dove Creek
Pine Creek
Thousand Springs
GREAT
SALT
LAKE
Bear River Bay
Willard Bay
Pineview Res
Ogden River
Weber R
Weber
Creek
WYOMING
UTAH
Echo Res
River
GREAT
SALT
LAKE
Jordan R
Provo
Deer Cr Res
UTAH LAKE
Spanish
Fork
NEVADA
UTAH
River
SEVIER
Sevier Bridge Reservoir
San Pitch
Gunnison Bend Res
LAKE
Sevier
Sevier L



EXPLANATION

Alpine	Grass (and forbs)	Barren
Coniferous forest	Northern desert shrub	Water
Aspen	Southern desert shrub	Urban
Pinon Juniper	Salt desert shrub	Urban 2,500–10,000 population
Mountain shrub	Cultivated and pasture	*Boundary of hydrologic subregions*

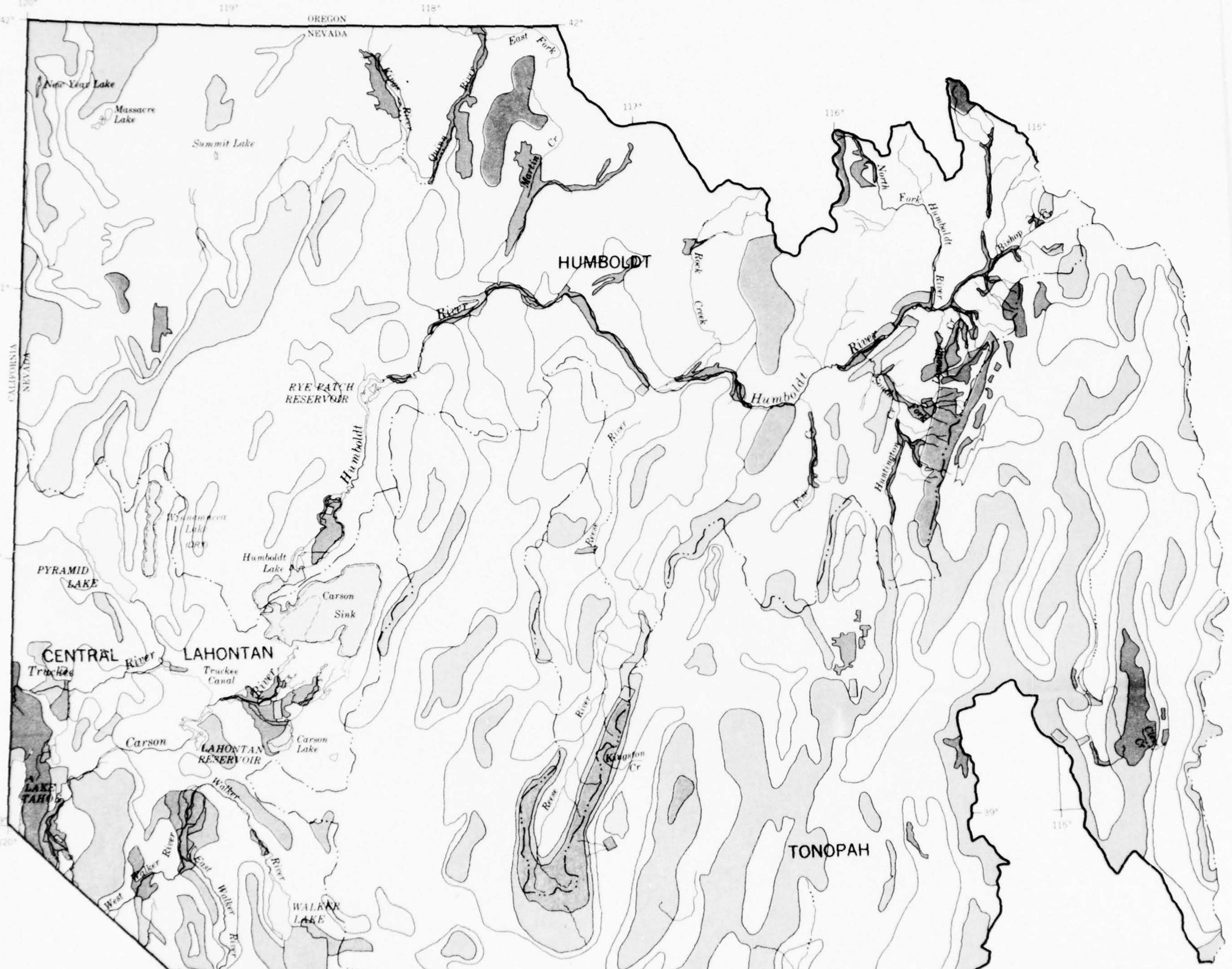
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

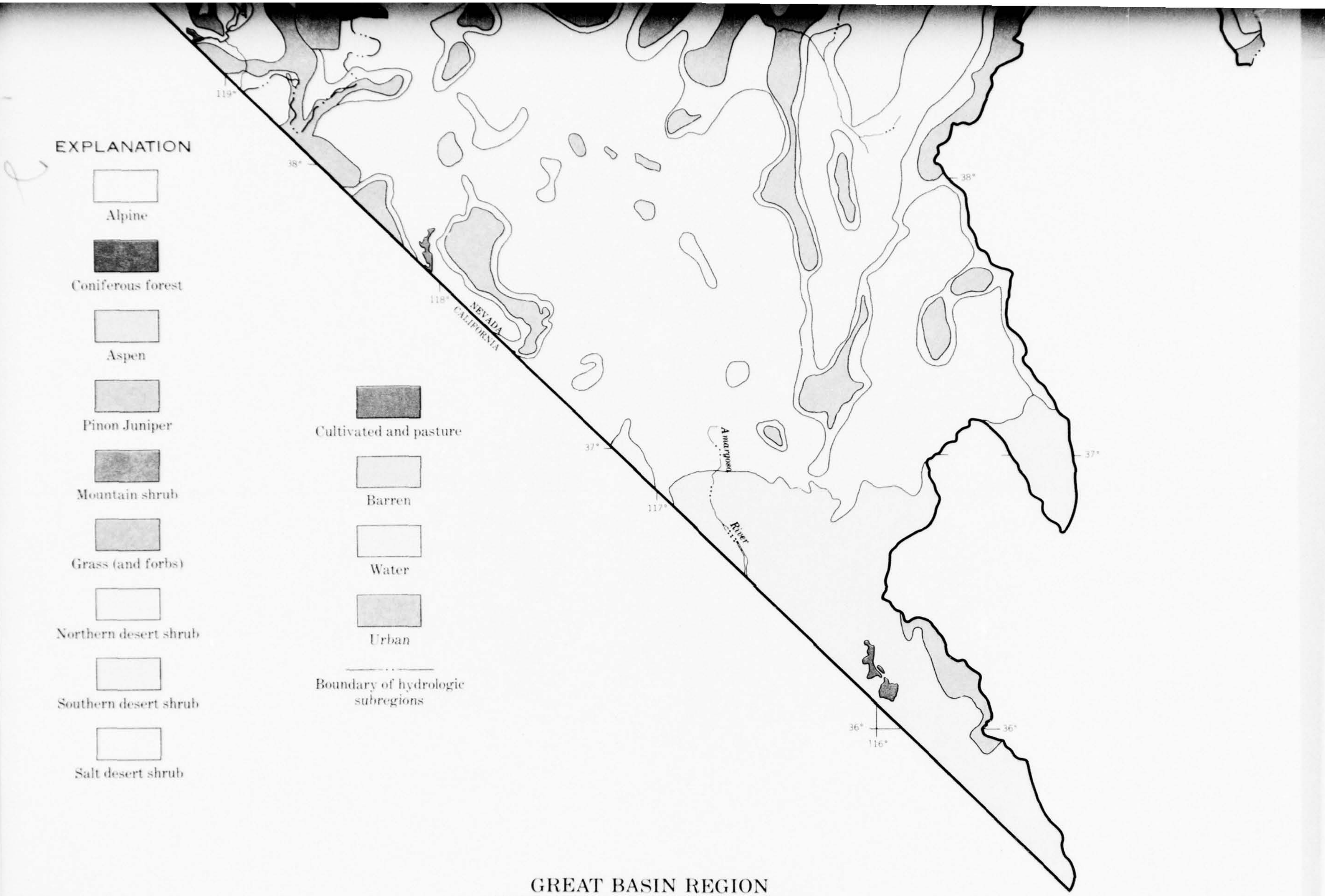
0 25 50 75 MILES

32 MILES TO THE INCH APPROXIMATELY

1970

VEGETAL COVER MAP


OREGON
NEVADA
CALIFORNIA
NEVADA
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
New Year Lake
Massacre Lake
Summit Lake
PYRAMID LAKE
RYE PATCH RESERVOIR
Humboldt Lake
Carson Sink
Carson Lake
LAHONTAN RESERVOIR
Truckee Canal
Truckee River
Carson
LAKE TAHOE
WALKER LAKE
Walker River
East Walker River
West Walker River
Humboldt River
North Fork Humboldt River
East Fork
Quinn River
Kings River
Martin Cr
Rock Creek
Reese River
Kingston Cr
Huntington Cr
South Fork
Bishop Cr
Pine Cr
120°
119°
118°
117°
116°
115°
42°
41°
40°
39°



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH APPROXIMATELY

1970

VEGETAL COVER MAP

cropland, and dry cropland. For urban and irrigation use, water can be brought to the land from distant sources, but dry land farming is dependent upon precipitation, generally requiring 12 to 20 inches annually for a successful operation.

Although other factors such as latitude, topography, climate, and elevation have contributing influences, production from the land for specific uses such as timber, grazing, or crops, requires another resource - water. A direct relationship exists between the relative value of the land resource, what it can produce, and the amount of precipitation or man conveyed water, it receives. In addition, desert lands also have potential as recreational and designated wilderness areas.

Mineral Resources

The Region contains vast mineral resources, both known and predictable by geologic environment, which can be developed as economic climate and demands permit. It is a major source of copper, lead, silver, mercury, barite, diatomite, magnesite, and phosphate rock. Lake brine is receiving increased attention as a source of minerals.

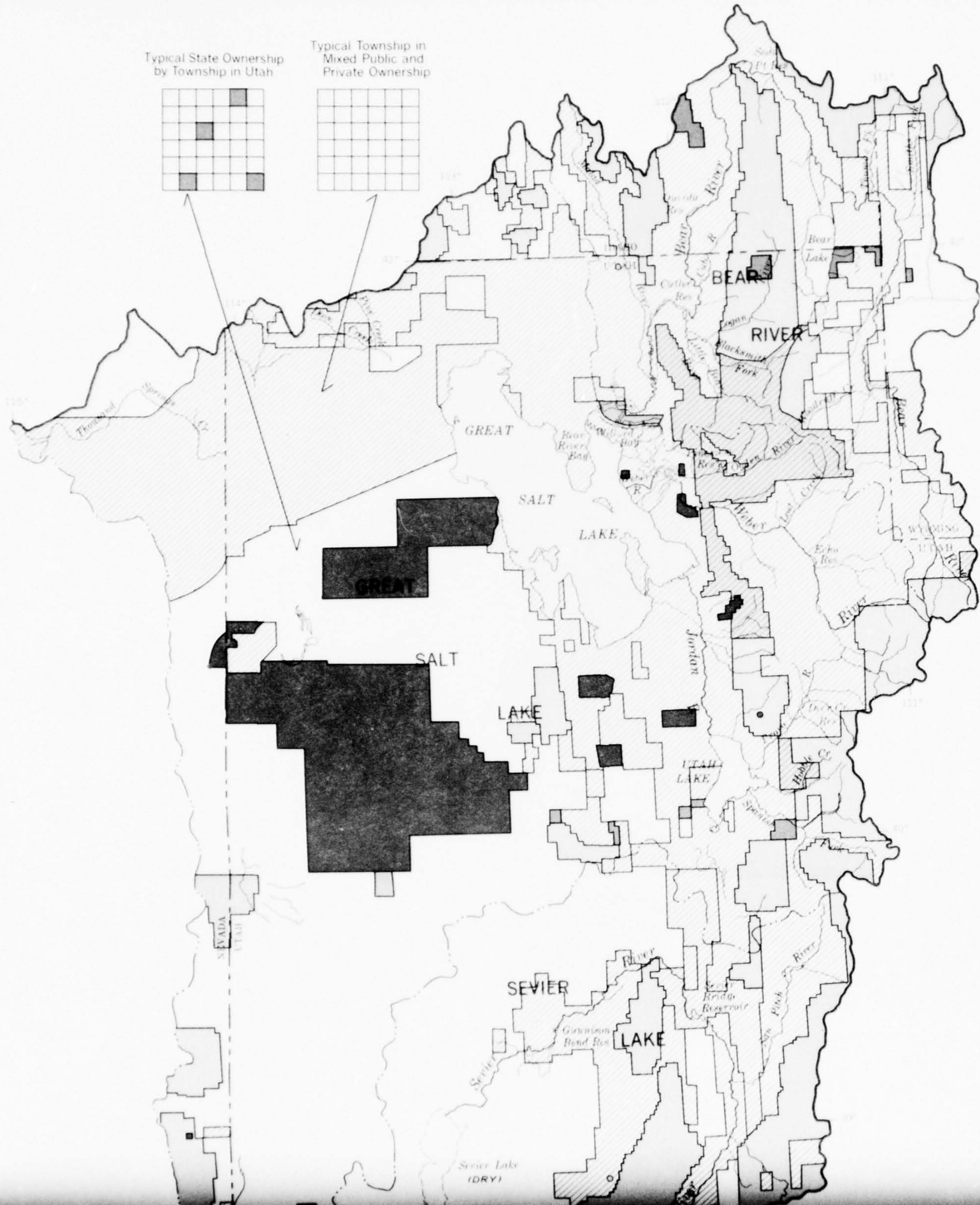
Open Space Resources

The Region has space in sufficient abundance to categorize it as a resource. It has distinct value for military, wildlife, and recreational use. Many industries are looking for potential sites where land is not limited and ample space and an unpolluted environment is available. The population in some smaller communities is increasing as the retirement and leisure-time population segments are attracted to sparsely populated areas.

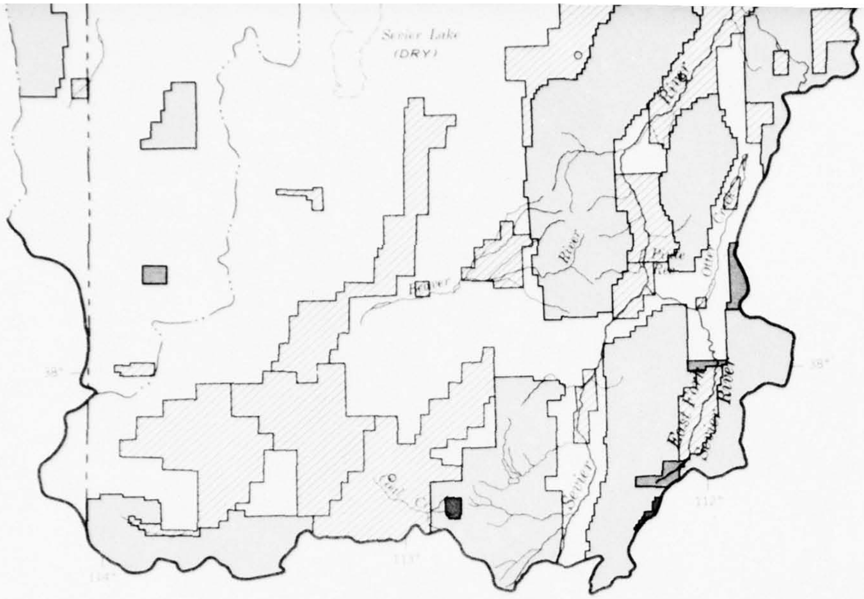
Land Ownership and Administration

Approximately 76 percent of the total land area is administered by the Federal Government and 24 percent by state, county and municipal governments, and private ownership as shown in Figure 3, and the land ownership maps following page 12.

Private land is scattered throughout the Region, generally in the fertile valleys where water exists. It is generally concentrated along major river systems near the base of the Sierra Nevada in the west and Wasatch Mountains in the east. A large amount of private land was originally railroad land grants. This has produced a checkerboard pattern of land ownership that stretches across the northern part of the Region.



Typical State Ownership by Township in Utah
Typical Township in Mixed Public and Private Ownership
GREAT SALT LAKE
GREAT SALT LAKE
BEAR RIVER
SEVIER LAKE
UTAH LAKE
Bear Lake
Jordan
Weber
Bear River Bay
Sevier Lake (DRY)
NEVADA
UTAH
WYOMING
Gunnison Bend Res
Sevier Bridge Reservoir
Blacksmith Fork
Echo Res



EXPLANATION

FEDERAL ADMINISTRATION

- Bureau of Land Management
- National Forest
- National Park Service
- Department of Defense (includes A.E.C.)
- Fish and Wildlife Refuge

INTERMINGLED

- Bureau of Land Management and Private
- *National Forest and Private*

PRIVATE OWNERSHIP

- Private, Municipal, County and other
- Indian Reservations

STATE OWNERSHIP

- State
- Larger Lakes
- Boundary of hydrologic subregions

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

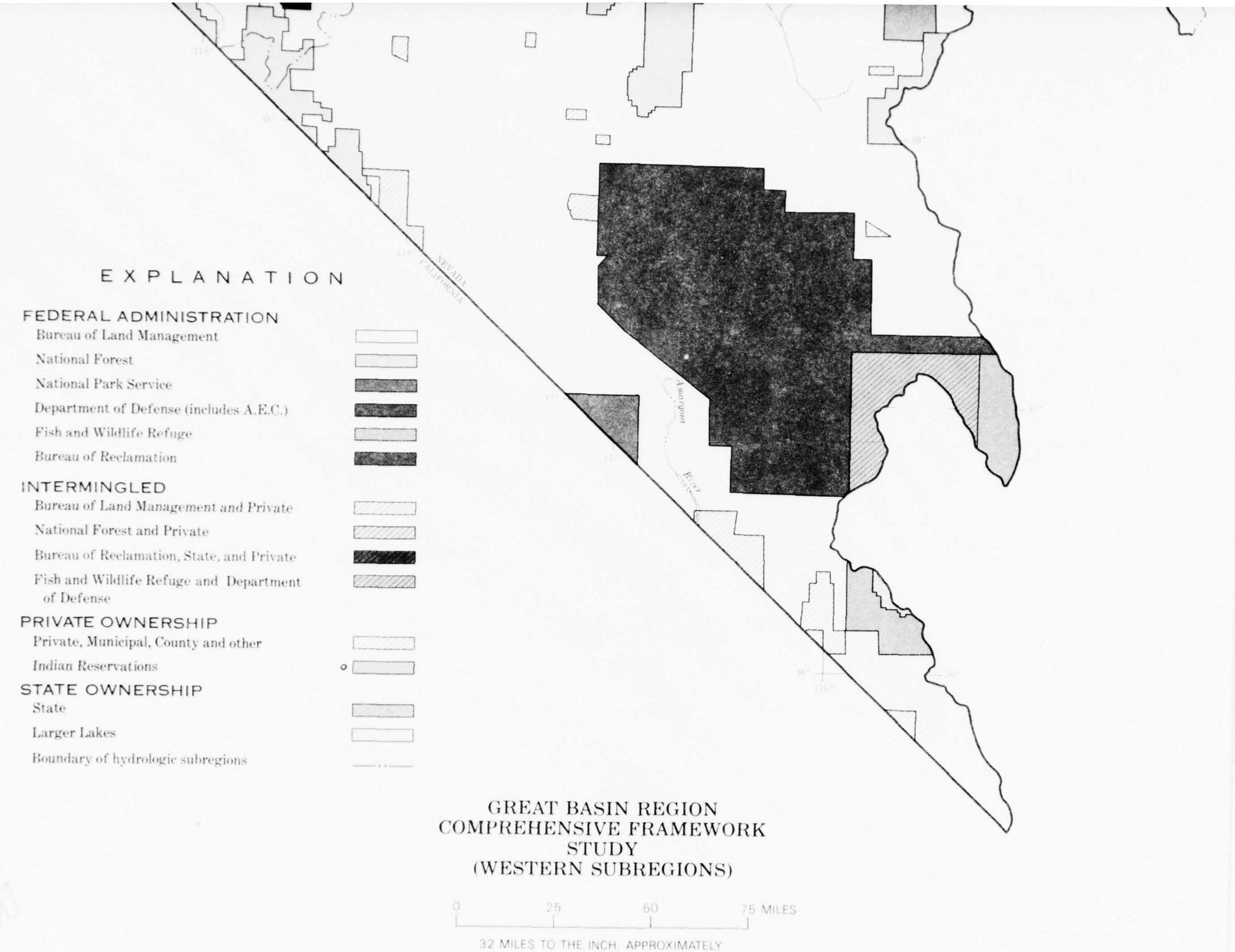
0 25 50 75 MILES

32 MILES TO THE INCH APPROXIMATELY

1970

GENERALIZED LAND OWNERSHIP AND ADMINISTRATION STATUS AS OF 1965


Typical Township in
Mixed Public and
Private Ownership
OREGON
NEVADA
CALIFORNIA
NEVADA
HUMBOLDT
CENTRAL
TONOPAH
New Year Lake
Massacre Lake
PYRAMID LAKE
Truckee
RYE PATCH RESERVOIR
Humboldt Lake
Carson Lake
WALKER LAKE
Humboldt
River
Rock Creek
North Fork
Kingston Cr



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

1970

GENERALIZED LAND OWNERSHIP AND ADMINISTRATION
STATUS AS OF 1965

Upon admission to statehood, various amounts of land were provided to states in aid of education. Different policies of land administration and management were used. Nevada and Utah represent the extremes; Nevada having disposed of virtually all its grant land, while Utah still retains most of its original grants. Nevada, however, received much less land than did Utah through the selection process.

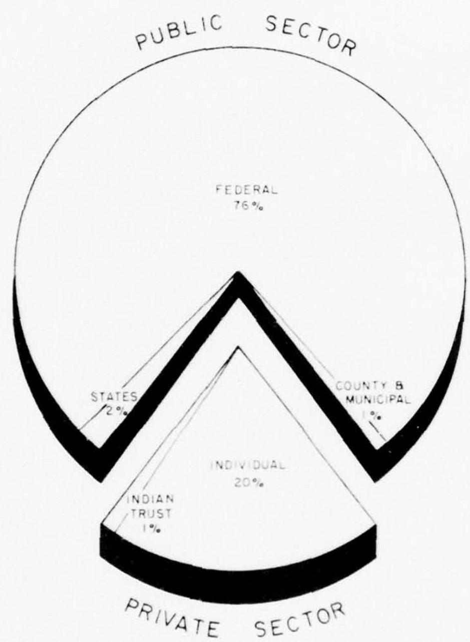


Figure 3. General land ownership and administration in the Great Basin Region.

Population Distribution

Population is concentrated in two major areas, the Wasatch Front in Utah and the Reno-Carson-Tahoe area in Nevada. Four counties, which make up the major part of the Wasatch Front area, include about 65 percent of the population. The Reno-Carson-Tahoe area comprises 11 percent. Sixty-five percent of the inhabitants live in urban areas exceeding 2,500 residents, and 80 percent of those in rural areas live in small towns and villages. Figure 4 shows the location of population centers.

Figure 4. Population centers - 1960

PART II

PRESENT STATUS OF WATER AND RELATED LAND DEVELOPMENT

Present Water Use and Development

The principal uses of water in the Great Basin Region have been estimated in the functional appendixes. Table 2 summarizes withdrawals and depletions under 1965 level of development by principal uses. Three classes of depletions, identified as nonirrigated wet meadows, unmanaged fish and wildlife and associated wetlands, and reservoir evaporation are included for added information. Not included, however, is evaporation from the three major terminal lakes, Great Salt Lake, Pyramid Lake, and Walker Lake. These lakes have been generally declining and a significant part of the evaporation has been derived from lake storage through the reference period (1931-1960). The magnitude of the annual net evaporation is on the order of 2.3 MAF, using 1965 year-end lake stages, distributed as follows: Great Salt Lake, 1.8 MAF; Pyramid Lake, 0.4 MAF; and Walker Lake, 0.1 MAF.

TABLE 2. PRINCIPAL WATER USES - 1965

Great Basin Region

Type of use	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Region
			(1,000 acre-feet)				
Withdrawals							
Municipal & industrial	75	319	20	12	54	13	493
Thermal electric power	0	5	0	0	1	1	7
Recreation	1	3	1	1	1	1	8
Minerals	1	72 1/	1	2	6	14	96
Irrigation	1,716	1,573	1,320	929	1,075	419	7,032
Fish and wildlife	350	255	55	25	271	61	1,017
Total	2,143	2,227	1,397	969	1,408	509	8,653
Depletions							
Municipal & industrial	24	103	7	4	20	3	161
Thermal electric power	0	5	0	0	1	1	7
Recreation	1	1	1	1	1	1	6
Minerals	1	8 1/	1	1	2	10	23
Irrigation	667	651	600	375	406	234	2,933 2/
Nonirrigated wet meadows	125	310	190	335	120	40	1,120
Managed fish and wildlife	169	165	55	25	259	61	734
Unmanaged fish and wildlife and associated wetlands	221	91	47	0	46	0	405
Reservoir evaporation	167	303	70	20	63	1	624 3/
Total	1,375	1,637	971	761	918	351	6,013

1/ An additional 14,000 A.F. of diversions and 5,000 A.F. of depletions are supplied from municipal and industrial water for copper smelter operations and included in municipal and industrial use.

2/ Includes 97,000 acre-feet from one-time ground-water storage; Sevier Lake 17,000 A.F., Humboldt 60,000 A.F. and Tonopah 20,000 A.F. annually.

3/ Does not include net evaporation from Great Salt Lake (1.8 MAF), Pyramid Lake (0.4 MAF), and Walker Lake (0.1 MAF).

Most of the 8.7 MAF withdrawals listed in Table 2 are from surface water sources. Ground-water withdrawal from wells provides only about 11 percent of the total. Irrigation uses about 80 percent of the combined withdrawals among the six principal uses shown in the table. Much of the depletion for nonirrigated wet meadows and reservoir evaporation is associated with irrigation.

Surface Water

Most water developments have been associated with surface water. These developments include storage reservoirs to regulate supply, and facilities to convey water to the various uses. The estimated active storage capacity in upstream lakes and reservoirs in 1965 was 4.3 MAF as shown in Table 3. There is an additional 598,000 acre-feet of active storage capacity in California that regulates waters used principally in the Central Lahontan Subregion.

About 76,000 acre-feet of storage capacity was developed between 1965 and 1970. The Great Salt Lake Subregion accounted for 46,000 acre-feet, Bear River Subregion 29,000 acre-feet and Sevier Lake Subregion 1,000 acre-feet.

Extensive conveyance facilities have been constructed to utilize available water. These vary from transbasin diversions and tunnels to conveyance systems from small springs and streams. The most extensive diversion and conveyance systems are associated with major streams, but practically all streams that produce a usable supply are diverted and utilized.

Water developments under construction or presently authorized will import approximately 136,000 acre-feet of additional water and provide additional storage and regulation of existing water. This water will be used primarily for municipal and industrial purposes in the Great Salt Lake Subregion, but substantial amounts will be available for irrigation by direct diversion, exchanges, and from return flows. Additional water will also accrue for waterfowl habitat from return flows.

TABLE 3. ESTIMATED ACTIVE STORAGE CAPACITY IN UPSTREAM LAKES AND RESERVOIRS - 1965

Great Basin Region

Subregion	Surface area	Active capacity
	(1,000 acres)	(1,000 acre-feet)
Bear River	97	1,642
Great Salt Lake	109	1,153
Sevier Lake	18	537
Humboldt	26	293
Central Lahontan	68 1/	666 2/
Tonopah	2	4
Region	320	4,295

1/ Includes 41,000 acres of Lake Tahoe in Nevada which is one-third the area of the lake.

2/ Includes 240,000 acre-feet of Lake Tahoe which is one-third the active capacity of the lake.

Ground Water

Ground-water development ordinarily refers to development of wells which are used extensively for domestic, stock, municipal, industrial, and irrigation purposes. Flowing wells have been developed in many areas in the Region, but pumped wells have accounted for most withdrawals. Individual yield rates of these pumped wells are as great as 8,600 gallons per minute, but average about 1,000 gallons per minute. The total number of wells in the Region is not known, but pumped wells, excluding domestic and stock wells, exceed 2,000 in number. The following tabulation shows estimated ground-water withdrawals from wells in 1965.

Subregion	Ground-water withdrawals
	(acre-feet)
Bear River	175,000
Great Salt Lake	306,000
Sevier Lake	280,000
Humboldt	140,000
Central Lahontan	42,000
Tonopah	98,000
Region	1,000,000 (rounded)

The large withdrawals in the Bear River, Great Salt Lake, and Sevier Lake Subregions are in areas of adequate recharge. Water levels fluctuate from year to year but remain relatively stable over the long term. However, concentrated pumping causes localized overdrafts. Similar conditions exist in several valleys of the Central Lahontan and Humboldt Subregions. In the drier parts of the Region, some groundwater pumping is from storage. Consequently, water levels will decline for many years before relative equilibrium will be reached.

Water Quality

The upstream surface waters generally have excellent quality; however, the water deteriorates as it moves downstream, increasing in salt concentration from natural sources, from irrigation return flows, and from other uses. Erosion caused by highly variable streamflow and runoff from unstable watersheds also causes deterioration of water quality.

Generally, in areas of natural recharge, the ground water is fresh; in areas of natural discharge, such as the Great Salt Lake, the ground water is 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 sink or playa. Here natural salts are concentrated by evaporation and locally saline ground water is usually present. The chemical quality of ground water varies considerably with depth. In most places, there is a progressive increase in dissolved solids with increasing depth.

Present Land Use and Development

Much land in the Region remains in an undeveloped condition. Multiple use of the land is almost universal. Primary uses such as minerals, military, urban, and transportation preclude most other uses. Irrigation, grazing, timber, wildlife, and recreation uses generally allow several simultaneous uses. For example, an area used for grazing may also be used for wildlife and recreation. Wilderness areas are used for recreation and wildlife habitat. The 1965 principal land uses are shown in Table 4.

TABLE 4. PRINCIPAL LAND USES - 1965

Great Basin Region

Principal use[1/]	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Region
				(1,000 acres)			
Irrigated cropland	497	452	378	335	262	190	2,114
Dry cropland	527	410	146	0	0	0	1,083
Grazing land	3,213	12,480	8,004	15,641	3,668	20,232	63,238
Timber	373	1,093	777	0	80	29	2,352
Urban and industrial	34	148	19	21	125	18	365
Outdoor recreation	35	92	82	70	10	141	430
Wilderness and scenic	35	25	0	35	0	34	129
Flood control measures	7	10	9	2	3	1	32
Military and related	0	1,861	0	0	137	2,964	4,962
Minerals	20	157	30	56	25	133	421
Fish and wildlife	119	180	99	613	230	815	2,056
Classified watershed	68	134	53	0	97	0	352
Transportation and utilities	57	134	112	140	91	77	611
Water control reservoirs	97	109	18	26	68	2	320

1/ Multiple uses of land are made in most categories so uses are not additive. Does not include all designations.

Watershed Treatment and Management

Treatment has been accomplished on about 27 million acres of watershed lands including many critical areas. Watershed management and treatment have improved domestic and municipal water supplies and streamflow regimen. High flood peaks, accompanied by mud and rock flows followed by periods of little or no streamflow, have virtually been eliminated from the treated watersheds. Approximately 11.5 million acres of land are so erodible and unproductive they are classed as frail lands or critical watershed areas. An additional 20 million acres are in poor condition.

Cropland

Irrigated cropland includes about 2.1 million acres. Most of this land is adjacent to the streams from which it receives water and is in areas where the frost free period is long enough to allow crops to mature. About 90 percent of this land produces forage crops, grown primarily to provide winter feed for livestock.

Alfalfa is the principal crop and small grains are next in acreage. Other crops such as corn for silage, sugar beets, grass hay, alfalfa seed, and truck and fruit crops are important in local areas. Cotton is grown on a small area in the southern part of the Tonopah Subregion.

Dry cropland includes about 1.1 million acres in the eastern subregions where the average annual precipitation is 12 to 18 inches. Small grains are grown in an alternate crop and fallow system. In 1965 about 37 percent of this land was in crop, 37 percent was fallow and 26 percent was idle.

Grazing

About 75 percent of the land area is grazed by livestock. Rangeland provides about 83 percent of the forage requirements for sheep and 16 percent for cattle. Cattle generally graze rangelands during summer months and are fed during winter months. Sheep, however, make extensive use of desert rangeland during winter. Rangelands are vital to the livestock industry. Lands used for grazing are used for many other purposes, including watershed, wildlife habitat, and recreation.

Timber

There are about 2.4 million acres of commercial forest land. Much of this timberland may never be harvested due to remoteness or designation for other uses, such as wilderness or watershed.

The timber producing land is distributed among five major forest types: Douglas fir, lodgepole pine, ponderosa pine, spruce-fir, and aspen. Production or harvest of timber in the Region is extremely low. Only about 2.6 million cubic feet were harvested in 1965, principally in the Sevier Lake Subregion.

Urban and Industrial

Most urban development has occurred in the valley areas along the Wasatch Front in the eastern subregions and along the eastern slope of the Sierra Nevada in the western subregions. As population increased, irrigated cropland has been converted to urban and industrial use. At the present time, the economy of many population centers is shifting from an agricultural to an industrial-commercial base. Generally, communities in the Bear River, Sevier Lake, Humboldt and Tonopah Subregions are associated with agriculture or mining. The major industrial developments have occurred in the Great Salt Lake and Central Lahontan Subregions. Most heavy industries are located in the Great Salt Lake Subregion and consist principally of iron and copper smelters, and oil refineries. Industrial development in the Central Lahontan Subregion is predominantly light industry and warehousing.

Transportation and Utilities

The Region is traversed by major highways, both east to west and north to south. It is served by four major railroads and several airlines. The major population centers are served by natural gas pipelines.

The electric utilities required about 5,500 gigawatt-hours (gwh) of electrical energy in 1965, including 3,000 gwh imported from neighboring systems. There has been no major change in the number of hydroelectric plants since 1930. Most of the plants are small and as they become obsolete their production is usually replaced from other sources. Over 70 percent of the total hydroelectric capacity is in seven plants in the Bear River and Great Salt Lake Subregions. Three thermal steam plants in 1965 had capacities exceeding 50,000 kilowatts, with one exceeding 250,000 kilowatts. Nineteen plants utilized internal combustion (Diesel) power, and one plant had a gas turbine. The maps following page 21 show the location of principal electrical facilities in the Region.

Outdoor Recreation

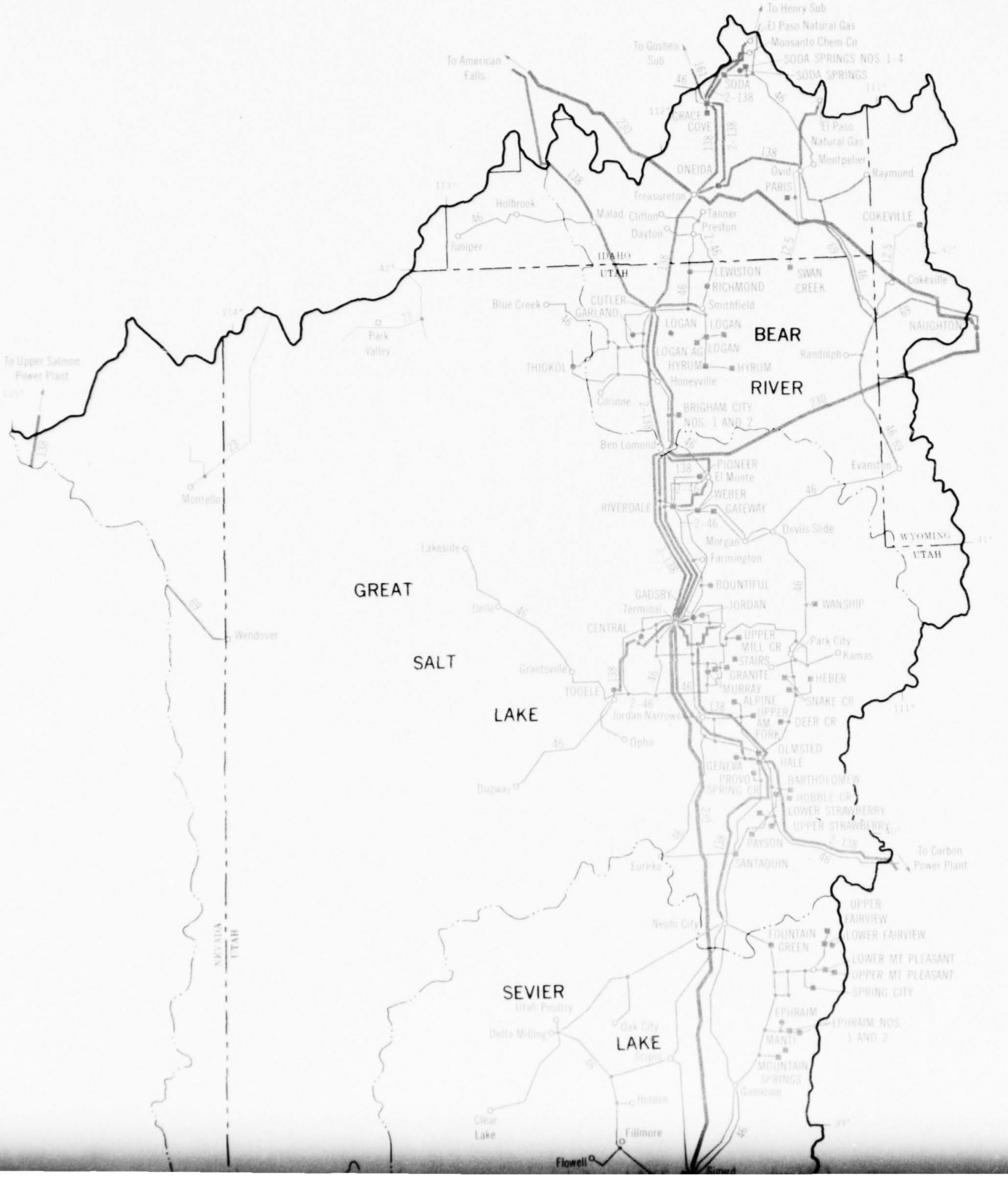
This Region offers a wide variety of opportunities for recreation. It contains natural areas ranging from deserts to mountains, from barren salt flats to forests and from dry lakebeds and salt lakes to sparkling mountain lakes and streams. It also contains numerous areas of scientific, geologic, natural and historic value that have been developed or preserved for recreational purposes.

Numerous campgrounds, picnic, and winter sport areas have been developed in mountains or canyons in close proximity to urban areas. Facilities for boating and other water-based recreation are available on many reservoirs and natural lakes. Most of the outdoor recreation development in urban centers has been for parks and golf courses.

About 16,000 acres of the Jarbidge Wilderness area in Nevada and about 35,000 acres of the Uinta Primitive area in Utah are in the Region. Other areas are classified as national scenic areas. These are Wheeler Peak and Ruby Mountains scenic areas in eastern Nevada, and Mt. Timpanogos scenic area in central Utah.

Flood Control

The existing flood control development includes flood forecasting, flood control reservoirs, levees and channels, watershed management and treatment, and flood plain management.



To Henry Sub
El Paso Natural Gas
Monsanto Chem Co
SODA SPRINGS NOS. 1-4
SODA SPRINGS
To Goshen Sub
To American Falls
SODA
GRACE
COVE
ONEIDA
El Paso Natural Gas
Montpelier
Raymond
Ovid
PARIS
Treasureton
Holbrook
Malad
Clifton
Tanner
Preston
Dayton
Juniper
COKEVILLE
IDAHO
UTAH
LEWISTON
RICHMOND
SWAN CREEK
Cokeville
Blue Creek
CUTLER
GARLAND
Smithfield
LOGAN
LOGAN AG
HYRUM
BEAR
RIVER
NAUGHTON
Randolph
Park Valley
To Upper Salmon Power Plant
THIOKOL
Honeyville
Corinne
BRIGHAM CITY NOS. 1 AND 2
Ben Lomond
PIONEER
El Monte
Evanston
Montello
WEBER
GATEWAY
RIVERDALE
Devils Slide
Morgan
Farmington
WYOMING
UTAH
Lakeside
GREAT
SALT
LAKE
BOUNTIFUL
GADSBY
Terminal
JORDAN
WANSHIP
CENTRAL
UPPER MILL CR
STAIRS
Park City
Kamas
Wendover
Delle
Grantsville
TOOELE
GRANITE
MURRAY
HEBER
SNAKE CR
ALPINE
UPPER AM FORK
DEER CR
Jordan Narrows
Ophir
Dugway
OLMSTED
HALE
GENEVA
PROVO
SPRING CR
BARTHOLOMEW
HOBBLE CR
LOWER STRAWBERRY
UPPER STRAWBERRY
PAYSON
SANTAQUIN
Eureka
To Carbon Power Plant
NEVADA
UTAH
Nephi City
UPPER FAIRVIEW
FOUNTAIN GREEN
LOWER FAIRVIEW
LOWER MT PLEASANT
UPPER MT PLEASANT
SPRING CITY
SEVIER
LAKE
Utah Poultry
Delta Milling
Oak City
Scipio
EPHRAIM
MANTI
EPHRAIM NOS. 1 AND 2
MOUNTAIN SPRINGS
Gunnison
Holden
Clear Lake
Fillmore
Flowell
Sigurd

EXPLANATION

MANTI Hydro power plant	Transmission lines:	
	230 KV	
TOOELE Fuel power plant	138 to 161 KV	
	69 KV	
Evanston Substation	46 KV	
	12.5 to 34 KV	
UC Under construction	Connecting lines	
Boundary of hydrologic subregions	Crossover lines	

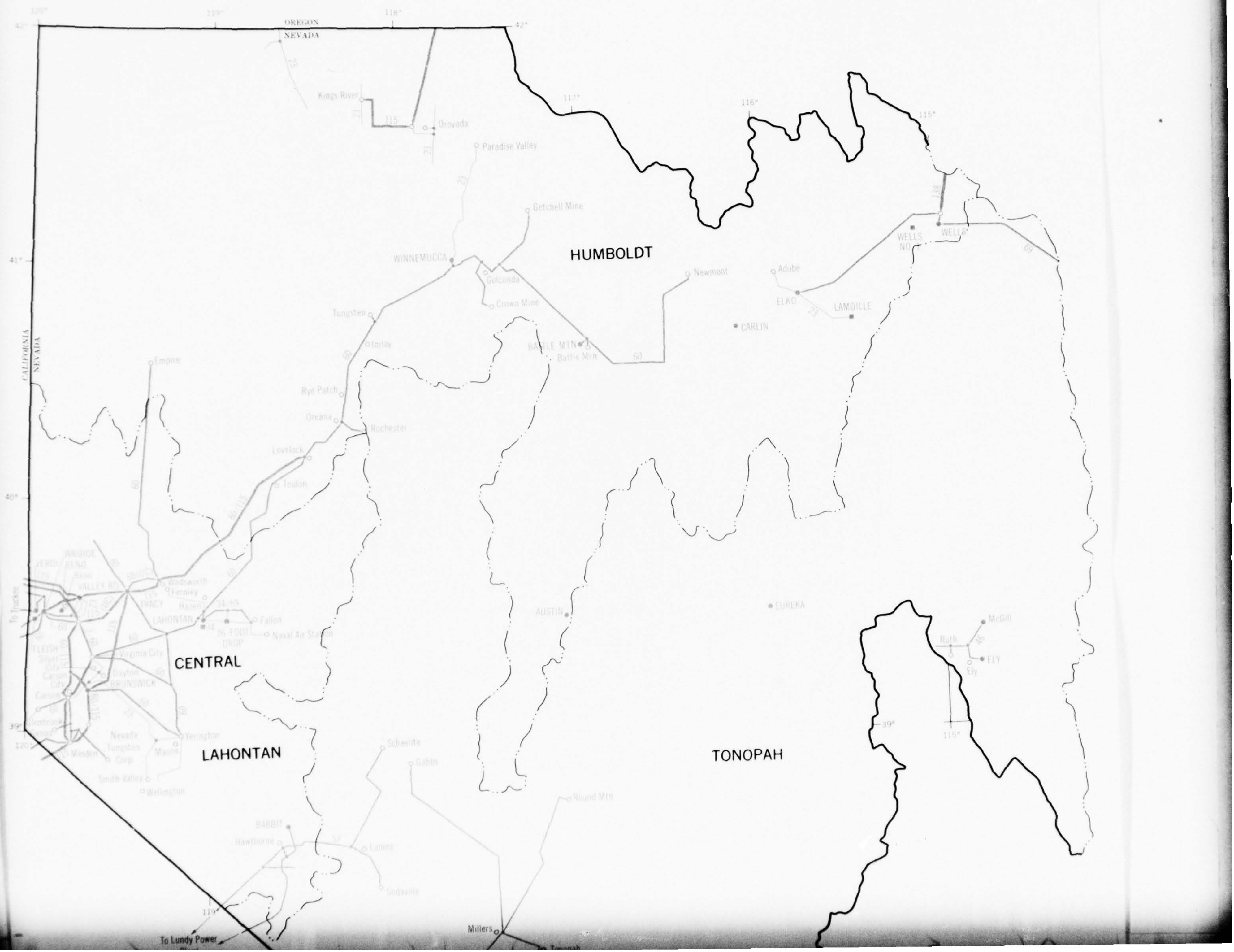
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

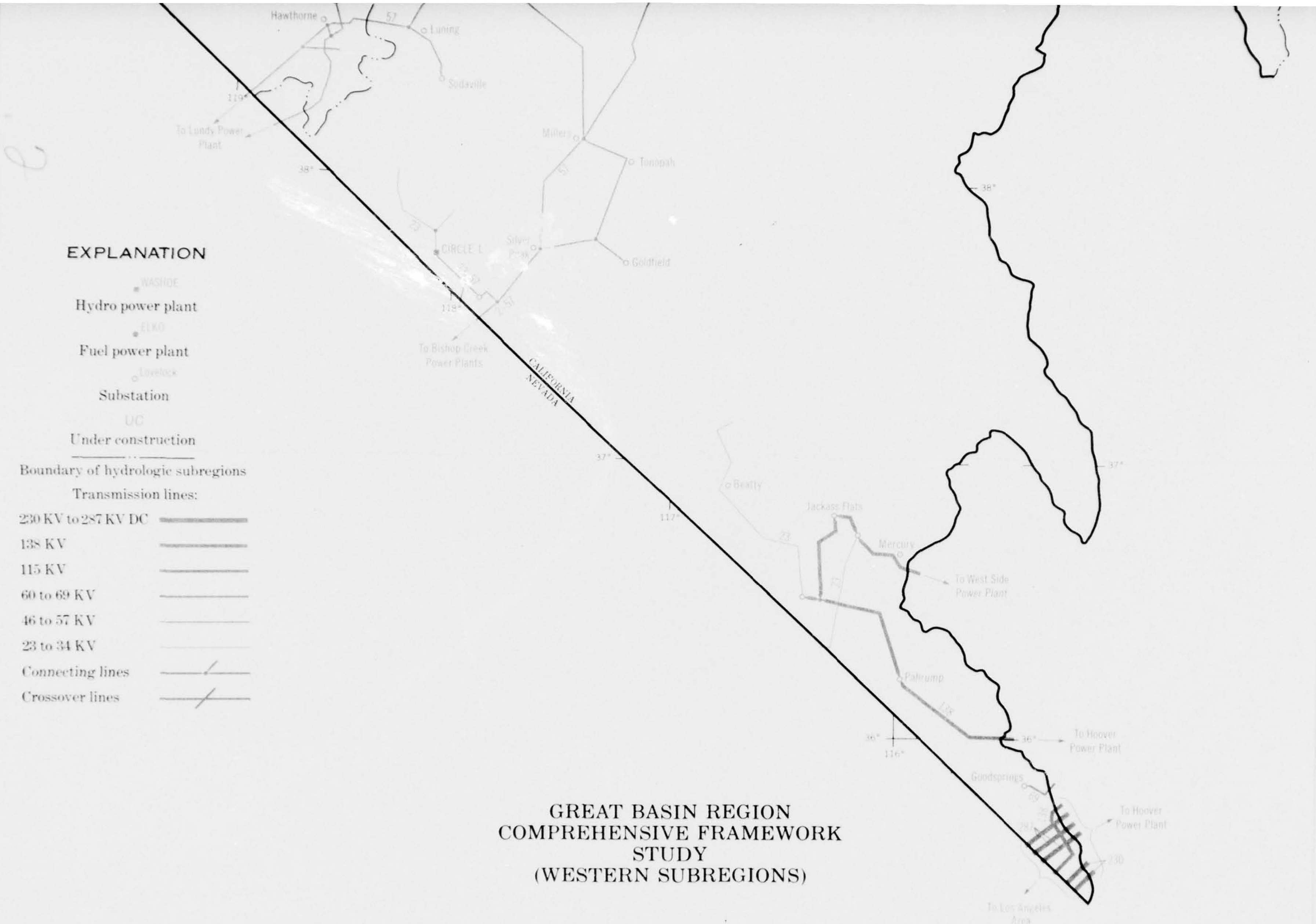
0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

PRINCIPAL ELECTRIC FACILITIES, JUNE 30, 1965


OREGON
NEVADA
CALIFORNIA
NEVADA
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
Kings River
Orovada
Paradise Valley
Getchell Mine
WINNEMUCCA
Golconda
Crown Mine
Newmont
Adobe
ELKO
LAMOILLE
CARLIN
WELLS
WELLS NO
BATTLE MTN
Battle Mtn
Tungsten
Imlay
Rye Patch
Oreana
Rochester
Lovelock
Toulon
Empire
WASHOE
RENO
Reno
VALLEY RD
Wadsworth
Fernley
TRACY
LAHONTAN
Fallon
26 FOOT DROP
Naval Air Station
Virginia City
Dayton
BRUNSWICK
Yerington
Mason
Minden
Nevada Tungsten Corp.
Smith Valley
Wellington
Schaeufe
Gabbs
Round Mtn
BABBIT
Hawthorne
Luning
Sodaville
Millers
AUSTIN
EUREKA
McGill
Ruth
ELY
Ely
To Truckee
To Lundy Power
Tonopah



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

1970

PRINCIPAL ELECTRIC FACILITIES, JUNE 30, 1965

There are about 100 reservoirs and lakes, excluding terminal lakes, with a total storage capacity of about 4.3 million acre-feet that help reduce flood damage although they are not specifically operated for flood control. Projects in operation for flood control in 1965 consisted of about 320,000 acre-feet of storage capacity in multiple-purpose reservoirs, operated on a flood forecast basis, and 2,200 acre-feet of storage capacity in small detention type reservoirs. In addition, there are 48 miles of levees, 70 miles of channels, and 24,400 acres of land with treatment measures.

The present average annual reduction in flood damage, due to existing measures, is about $1.5 million. Residual average annual damages are about $5.3 million. These damages have been divided into upstream cost, $2.2 million, and downstream cost, $3.1 million.

Military and Related

Military and related activities use about 5 million acres, mainly in remote and undeveloped areas. This includes the Atomic Energy Commission testing site in the Tonopah Subregion, and the Wendover Bombing Range and Dugway Proving Grounds in the Great Salt Lake Subregion. Usually these lands are restricted to military and related activities.

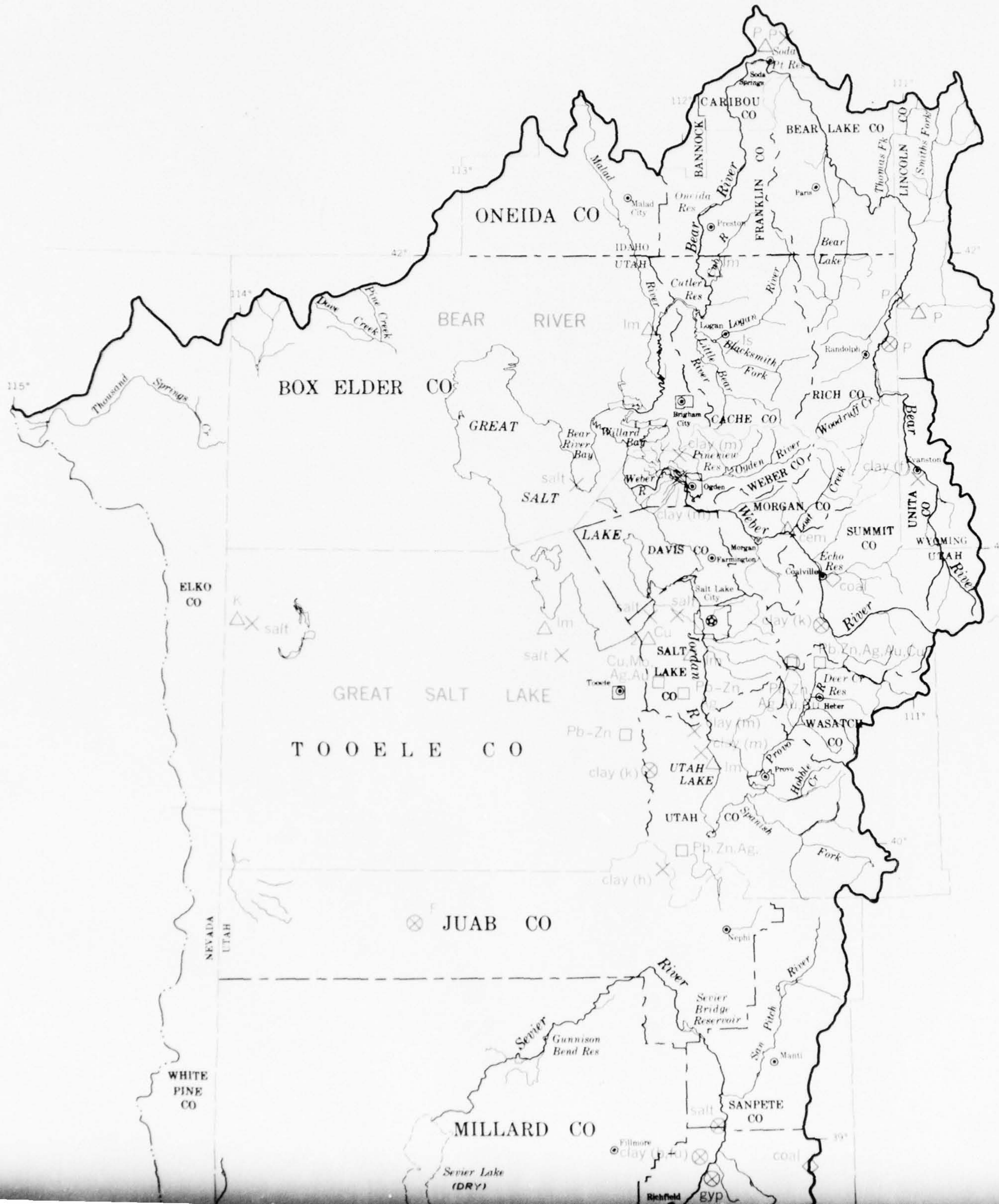
Minerals

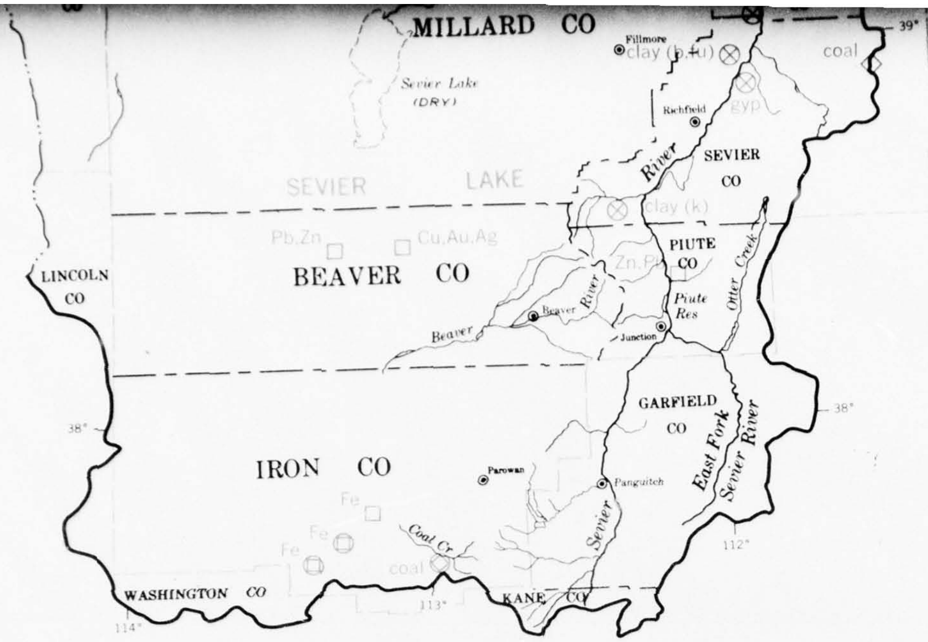
In 1965, 421,000 acres of land were utilized for mineral production. These lands are generally dispersed over the Region with the predominant use occurring in the Great Salt Lake and Tonopah Subregions. The maps following page 22 show the types of minerals and the location of principal mineral producing operations in 1965.

In 1965 metals accounted for nearly 85 percent, nonmetallic minerals about 15 percent, and fuels less than 1 percent of the total mineral production. Copper comprised over half of the value of all mineral output, and molybdenum, gold, iron ore, and sand and gravel were the next four in value of commodities produced.

Fish and Wildlife

A significant portion of the total area of fishing water is in manmade reservoirs. In 1965 an estimated 1.8 million man-days of fishing occurred. Coldwater fishing accounted for 1 million man-days, and warmwater fishing the remainder. Miles of streams suitable for fishing are decreasing.


ONEIDA CO
BANNOCK
CARIBOU CO
BEAR LAKE CO
LINCOLN CO
FRANKLIN CO
BOX ELDER CO
CACHE CO
RICH CO
WEBER CO
MORGAN CO
DAVIS CO
SUMMIT CO
UNITA CO
SALT LAKE CO
WASATCH CO
UTAH CO
TOOELE CO
JUAB CO
MILLARD CO
SANPETE CO
ELKO CO
WHITE PINE CO
IDAHO
UTAH
WYOMING
NEVADA
BEAR RIVER
GREAT SALT LAKE
UTAH LAKE
Bear River
Bear Lake
Malad City
Preston
Paris
Logan
Brigham City
Ogden
Randolph
Evanston
Morgan
Farmington
Salt Lake City
Coalville
Tooele
Heber
Provo
Nephi
Manti
Fillmore
Richfield
Soda Springs
Sevier Lake (DRY)
Sevier Bridge Reservoir
Gunnison Bend Res
Echo Res
Deer Cr Res
Cutler Res
Oneida Res
Pineview Res
Willard Bay
Bear River Bay
Jordan R
Weber R
Thousand Springs
Pine Creek
Dove Creek
Thomas Fk
Smiths Fork
Blacksmith Fork
Little Bear River
Woodruff Cr
Lost Creek
Provo
Hobble Cr
Spanish Fork
San Pitch River
Sevier River
salt
clay (m)
clay (k)
clay (h)
clay (f)
lm
ls
cem
coal
gyp
Cu
Cu,Mo,Ag,Au
Pb-Zn
Pb,Zn,Ag,Au,Cu
Pb,Zn,Ag.
P
K
115°
114°
113°
112°
111°
42°
41°
40°
39°



EASTERN SUBREGIONS

EXPLANATION

METALS

One deposit or mine

Several deposits or mines

Copper smelter, Garfield, Utah

Economic boundaries

Hydrologic Subregion boundary between Eastern and Western Subregions

Au-Gold
Ag-Silver
Cu-Copper
Fe-Iron ore
Mo-Molybdenum
Pb-Lead
Zn-Zinc

NONMETALLIC MINERALS

One deposit or mine

Several deposits or mines

Processing plant

cem-cement
clay:
types
(f)-fire
(b)-Bentonite
(fu)-Fullers earth
(h)-Halloysite
(k)-Kaolin or refractory
(m)-Miscellaneous or common
F-Fluorspar
gyp-Gypsum
lm-Lime (plant)
ls-Limestone (quarry)
P-Phosphate rock

K-Potassium salts (plant)
salt-salt
(Note: Stone and sand and gravel operations are not shown. Nearly every county produces stone and sand and gravel.)

MINERAL FUELS

Coal mine

Several coal deposits or mines

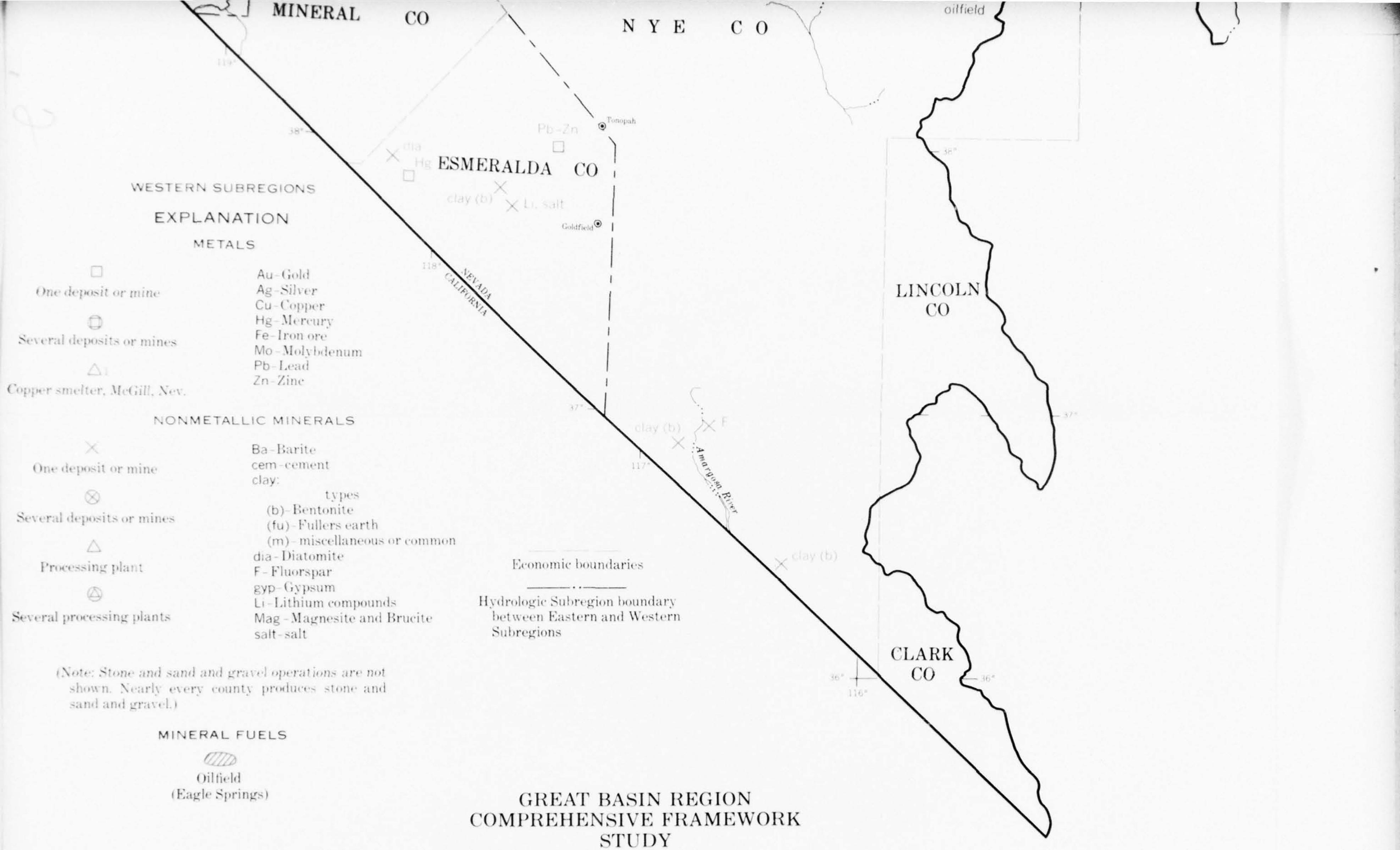
GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

0 25 50 75 MILES
32 MILES TO THE INCH, APPROXIMATELY

1970

LOCATION OF THE PRINCIPAL MINERAL PRODUCING OPERATIONS, 1965


OREGON
NEVADA
CALIFORNIA
NEVADA
WASHOE CO
HUMBOLDT CO
PERSHING CO
ELKO CO
LANDER CO
EUREKA CO
WHITE PINE CO
CHURCHILL CO
MINERAL CO
NYE CO
STOREY CO
LYON CO
ORMSBY CO
DOUGLAS CO
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
New Year Lake
Massacre Lake
Summit Lake
PYRAMID LAKE
Winnemucca Lake (DRY)
RYE PATCH RESERVOIR
Humboldt Lake
Carson Sink
Carson Lake
LAHONTAN RESERVOIR
WALKER LAKE
LAKE TAHOE
Truckee Canal
Humboldt River
Truckee River
Carson River
Walker River
East Walker River
West Walker
Reese River
Kings River
Quinn River
East Fork
Martin Cr
Rock Creek
North Fork Humboldt
Marys River
Bishop Cr
Lamoille Cr
South Fork
Huntington Cr
Pine Cr
Kingston Cr
Cleve Cr
Winnemucca
Lovelock
Fallon
Reno
Virginia City
Minden
Yerington
Hawthorne
Austin
Eureka
Elko
Ely
Hg
Fe
Au,Ag
Au
Ba
Cu
Zn,Pb
Cu,Mo,Au
Ag,Pb,Zn
gyp
dia
clay (m)
cem.dia
clay (fu)
salt
Mag
oilfield
42°
41°
40°
39°
120°
119°
118°
117°
116°
115°



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

LOCATION OF THE PRINCIPAL MINERAL PRODUCING OPERATIONS, 1965

In 1965, 1.3 million man-days of hunting occurred. Big game hunting accounted for about half of the hunting activity.

Most of the natural waterfowl areas occur along the eastern shore of the Great Salt Lake in Utah and in the Carson-Humboldt sink areas in Nevada. Parts of these areas have been developed and are managed for waterfowl propagation and hunting. The adjacent undeveloped areas also contribute to waterfowl hunting opportunities.

The Region is well known for its big game hunting, particularly mule deer. The Sevier Lake and Humboldt Subregions support the largest mule deer herds. All big game hunting is closely managed by the respective States. Management and development consists mainly of land acquisition and habitat restoration for big game.

PART III

REGIONAL NEEDS AND DEMANDS

This section shows, in general, the needs and demands as presented in the other appendixes. Adjustments and changes to match needs with available resources are discussed in Part V, Regional Comprehensive Framework Plan. Since the plan shows how needs and demands can be met, there is some duplication in Parts III and V. To reduce duplication, some subregional needs are discussed in Part V as planned development.

Economic Base and Projections

The OBE-ERS economic base and projections were used to establish needs and demands for the Region in most functional areas. The projected needs are based on historical trends and foreseeable development. These projections form the basis for the framework plan needs and provide a base from which alternative needs can be related.

Some appendixes are more closely related to these projections than are others. Projections for agricultural production are actually given by OBE-ERS. Many other future demands are based on population projections by OBE-ERS, such as recreation and electric power which utilize per capita demand rates in conjunction with the projections. Mineral production is based on projected national demands rather than regional OBE-ERS projections. Economic data are based on Economic Subregions. The frontispiece maps show the hydrologic and economic subregion boundaries.

Population and Employment Characteristics

The estimated population of the Great Basin Region in 1965 was one million inhabitants. The population for the period 1930-1965 increased 111 percent. This compares to 57 percent for the United States, 161 percent for the western states, and 108 percent for the mountain states. Table 5 shows distribution and growth of the six subregions.

The projected population growth rates used for the OBE-ERS projections were based on Bureau of the Census Series C projections, embodying an assumed substantial decline in fertility rates from the 1962-65 level. The Series C population estimate gives an average annual growth rate of 1.3 percent for the period under study.

TABLE 5. POPULATION DISTRIBUTION AND GROWTH

Great Basin Region

Economic subregion	Population 1930	Population 1965	Percent change 1930-1965
Bear River	70,228	90,000	28
Great Salt Lake	336,428	800,000	138
Sevier Lake	60,090	49,000	-18
Humboldt	19,454	28,000	44
Central Lahontan	42,634	166,000	290
Tonopah	16,837	18,000	7
Region	545,671	1,151,000	111

The regional population is projected to be 3.2 million by 2020. This represents an increase of 178 percent over the 55-year period. The rates of change in population vary widely among the subregions. Figure 5 shows present and projected subregional populations. All are projected to increase except the Sevier Lake Subregion.

In general, regional employment in 2020 is projected to increase as shown in Table 6. The largest percentage increases are in manufacturing, in business and repair services, and in medical, educational, and other professional services. A large percentage increase in finance, insurance, and real estate is projected in the western subregions.

Decreases in regional employment are forecast for agriculture, forestry and fisheries, for mining, and for petroleum refining. This reflects increased efficiency in operation which results in fewer employees needed to sustain increased levels of activity. Although in the western subregions entertainment and recreational services are projected to decrease about 10 percent, it is believed that since this sector includes gaming, it will increase substantially.

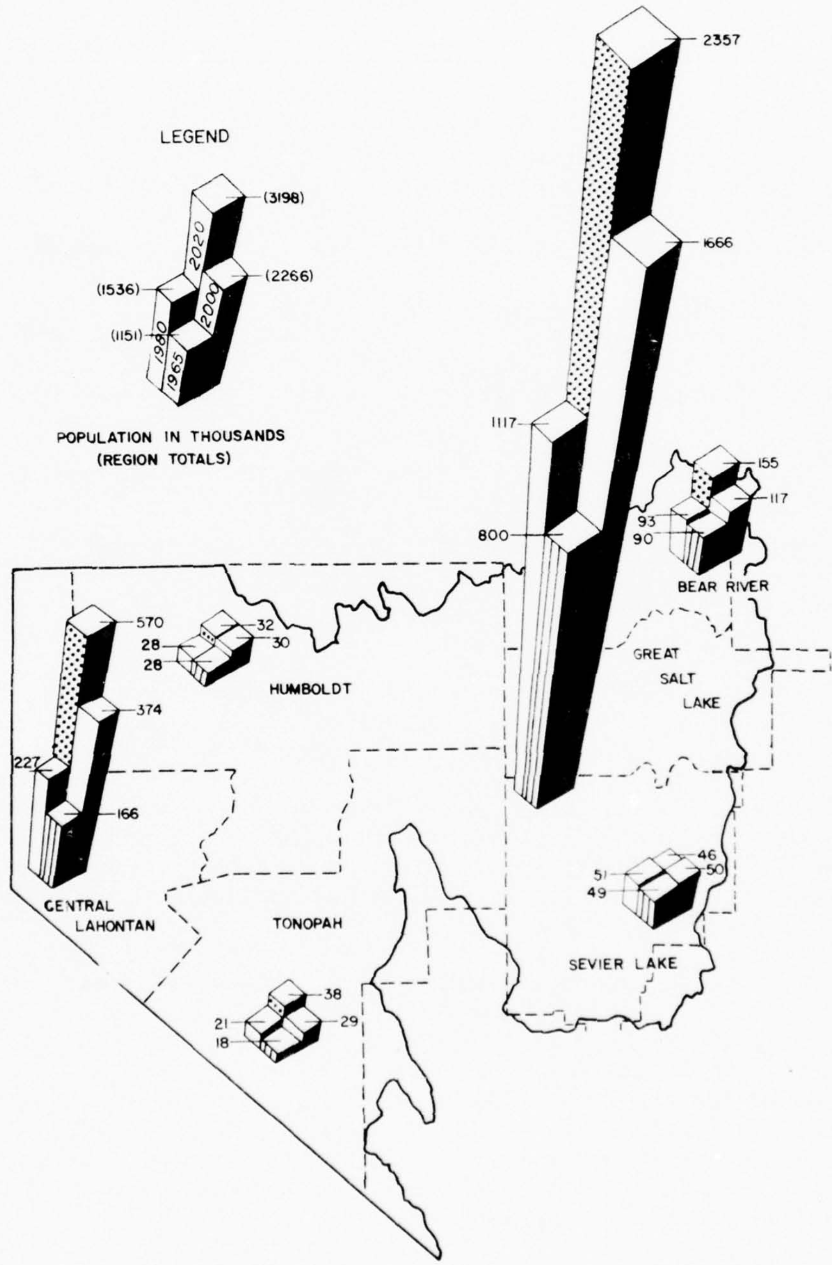


Figure 5. Projected population growth by economic subregions

TABLE 6. POPULATION, EMPLOYMENT AND PARTICIPATION RATE

Great Basin Region

	1965	1980	2000	2020
Eastern economic subregions				
Population - (thousands)	939	1,260	1,833	2,558
Employment - (thousands)	328	477	717	1,023
Participation rate - (empl/pop.)	0.35	0.38	0.39	0.40
Western economic subregions				
Population - (thousands)	212	276	433	640
Employment - (thousands)	89	111	174	256
Participation rate - (empl/pop.)	0.42	0.40	0.40	0.40
Region				
Population - (thousands)	1,151	1,536	2,266	3,198
Employment - (thousands)	417	588	891	1,279
Participation rate - (empl/pop.)	0.36	0.38	0.39	0.40

OBE-ERS Projections of Agricultural Production

Base year (1965) and projected agricultural production, shown on Table 7, represent the Region's share of national requirements for food and fiber. This allocation of food and fiber requirements was distributed among the subregions. It is the base from which agricultural water and land needs were defined and proposed developments were evaluated. Projections of alfalfa seed and cotton production were not included in the OBE-ERS data. These were added and projected to increase at the same rate as alfalfa hay and nationwide cotton production, respectively.

Crop yields were projected by local universities and increase about 40 to 150 percent above 1965 yields. The projection for sugar beet yield in the Bear River Subregion appears low since the present average of 17.2 tons/acre, as reported by Utah-Idaho Sugar Company, has approached the projected 2020 yield of 17.5 tons/acre. A more realistic projection of 25 tons/acre would reduce the 2020 acreage requirements by 26,800 acres. Projections for alfalfa seed in the Humboldt and Tonopah Subregions are also low since present yields and production exceed 2020 projections.

TABLE 7. AGRICULTURAL PRODUCTION

Great Basin Region

Commodity	Unit (1,000)	1965 1/	1980	2000	2020
Feed grains					
Corn	bu.	120	125	150	165
Oats	bu.	875	920	1,100	1,200
Barley	bu.	7,700	9,500	12,000	17,000
Hay and forage					
Hay	ton	2,118	2,200	2,600	2,900
Silage	ton	517	540	640	710
Pasture 2/	AUM	1,542	2,100	2,300	2,500
Rangeland pasture 2/	AUM	3,966	4,200	5,200	5,800
Seed crops					
Alfalfa seed 2/	cwt.	81	85	100	110
Food crops					
Wheat	bu.	8,238	10,700	12,000	14,000
Vegetables	cwt.	-	2,400	3,100	4,000
Noncitrus fruits	ton	-	40	50	70
Sugar	ton	457	1,300	2,000	2,800
Potatoes	cwt.	1,048	1,500	2,000	2,600
Fiber crops					
Cotton 2/	bl.	5	6	7	8
Cotton seed 2/	ton	12	13	15	18
Meat animals					
Beef and veal	lb. 3/	-	457,000	610,000	800,000
Pork	lb. 3/	-	11,000	15,000	19,000
Lamb and mutton	lb. 3/	-	73,000	97,000	127,000
Poultry products					
Farm chickens	lb.	-	4,700	6,200	8,000
Turkeys	lb. 3/	-	106,000	140,000	180,000
Broilers	lb. 3/	-	6,000	8,000	10,000
Eggs	ea.	185,952	327,000	430,000	560,000
Dairy					
Milk	lb.	737,769	940,000	1,225,000	1,580,000

1/ 1964 Census of Agriculture.
2/ Not projected by OBE-ERS.
3/ Liveweight.

Water Requirements

Diversion requirements are projected to increase by 2.3 million acre-feet and depletions by 1.5 million acre-feet from 1965 to 2020. This is about a 25 percent increase in both diversions and depletions.

Irrigation will continue to be the largest user of water. About 50 percent of the depletions would be for this use. Municipal and industrial demands account for the largest volume increase in diversions and depletions. These projected demands, based on past trends, are high when competing demands for water in this arid region are considered.

Electric power demand for cooling water would increase 1,700 percent from 1965 to 2020 even though total use is small.

Table 8 shows the withdrawal and depletions for the Region. This table reflects the adjustments that have been made to accommodate the Comprehensive Framework Plan.

TABLE 8. WATER REQUIREMENTS - REGIONAL SUMMARY

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
		(1,000 acre-feet)			
Withdrawals					
Municipal & industrial	493	721	1,172	1,872	+1,379
Thermal electric power	7	13	43	124	+ 117
Recreation	8	13	20	32	+ 24
Minerals	96	170	200	243	+ 147
Irrigation	7,032	7,109	7,292	7,483	+ 451
Fish and wildlife	1,017	1,068	1,117	1,214	+ 197
Total	8,653	9,094	9,844	10,968	+2,315
Depletions					
Municipal & industrial	161	250	469	871	+ 710
Thermal electric power	7	13	43	124	+ 117
Recreation	6	7	9	15	+ 9
Minerals	23	49	62	85	+ 62
Irrigation	2,933	3,030	3,235	3,455	+ 522
Nonirrigated wet meadows	1,120	1,082	980	910	- 210
Managed fish and wildlife	734	836	939	1,099	+ 365
Unmanaged fish & wildlife & associated wetland	405	364	364	309	- 96
Reservoir evaporation	624	600	648	678	+ 54
Total	6,013	6,231	6,749	7,546	+1,533

Note: Evaporation from terminal lakes is not included.

Land Requirements

The OBE-ERS production requirements were translated into land acreage needs for principal uses on a regional basis. Subregional requirements were determined using past trends, population projections, and available resources. The need for land varies with intensity and efficiency of use, and the means selected for meeting a requirement. For example, forage requirements for red meat production could be met entirely on irrigated cropland or on combinations of dry cropland, rangeland, and irrigated croplands.

The projected regional land requirements for various uses are shown in Table 9. The acreage needed for grazing and timber is projected to decrease as needs for other uses increase. Production on remaining grazing and timber lands is projected to increase.

TABLE 9. LAND REQUIREMENTS - REGIONAL SUMMARY

Great Basin Region

Principal use[1/]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	2,114	2,104	2,098	2,120	+ 6
Dry cropland	1,083	1,074	1,082	1,152	+ 69
Grazing land	63,238	62,481	61,757	60,820	-2,418
Timber	2,352	2,257	2,237	2,217	- 135
Urban and industrial	365	434	533	661	+ 296
Outdoor recreation	430	896	1,413	1,928	+1,498
Wilderness and scenic	129	950	950	950	+ 821
Flood control measures	32	67	128	160	+ 128
Military and related	4,962	4,962	4,962	4,962	0
Minerals	421	856	1,044	1,270	+ 849
Fish and wildlife	2,056	3,362	3,667	3,989	+1,933
Classified watershed	352	427	510	608	+ 256
Transportation and utilities	611	706	770	811	+ 200
Water control reservoirs	320	321	362	379	+ 59

1/ Multiple uses of land are made in many categories.

Within the Great Salt Lake and Central Lahontan Subregions, 297,000 and 97,000 acres, respectively, of additional land would be needed for urban and industrial, and for transportation and utilities use by 2020. Much of this would come from presently irrigated land.

Minerals

Demands for mineral resources are based on projections of the Region's contribution to meet national needs and demands as determined by the U.S. Bureau of Mines. The demand for most mineral construction materials has been and would continue to be met by production from resources within the Region. The demand for oil and natural gas has been and would be met by imports from other regions. Metals and the remaining nonmetallic minerals are mined largely for use outside the Region. It is assumed that needs and demands for minerals not mined in the Region will be satisfied by imports.

Watershed Management

Watershed lands are used for many purposes and if not properly protected are damaged from erosion, flood, sediment, and fire. Annual damages shown in Table 10 need to be reduced. As development takes place, the potential for damage will increase. Tables 11 and 12 indicate the land treatment measures needed on about 11.5 million acres. About 700,000 acres are critical areas needing intensive treatment measures, but all land should be managed to maintain and improve watershed conditions. The maps following page 32 show the watershed treatment and management areas.

TABLE 10. AVERAGE ANNUAL WATERSHED DAMAGES, 1965

Great Basin Region

Subregion	Erosion	Flood & sediment 1/	Fire	Total
		($1,000)		
Bear River	69	507	566	1,142
Great Salt Lake	124	1,880	1,918	3,922
Sevier Lake	239	652	1,137	2,028
Humboldt	204	673	3,868	4,745
Central Lahontan	62	1,223	2,165	3,450
Tonopah	144	385	742	1,271
Region	842	5,320	10,396	16,558

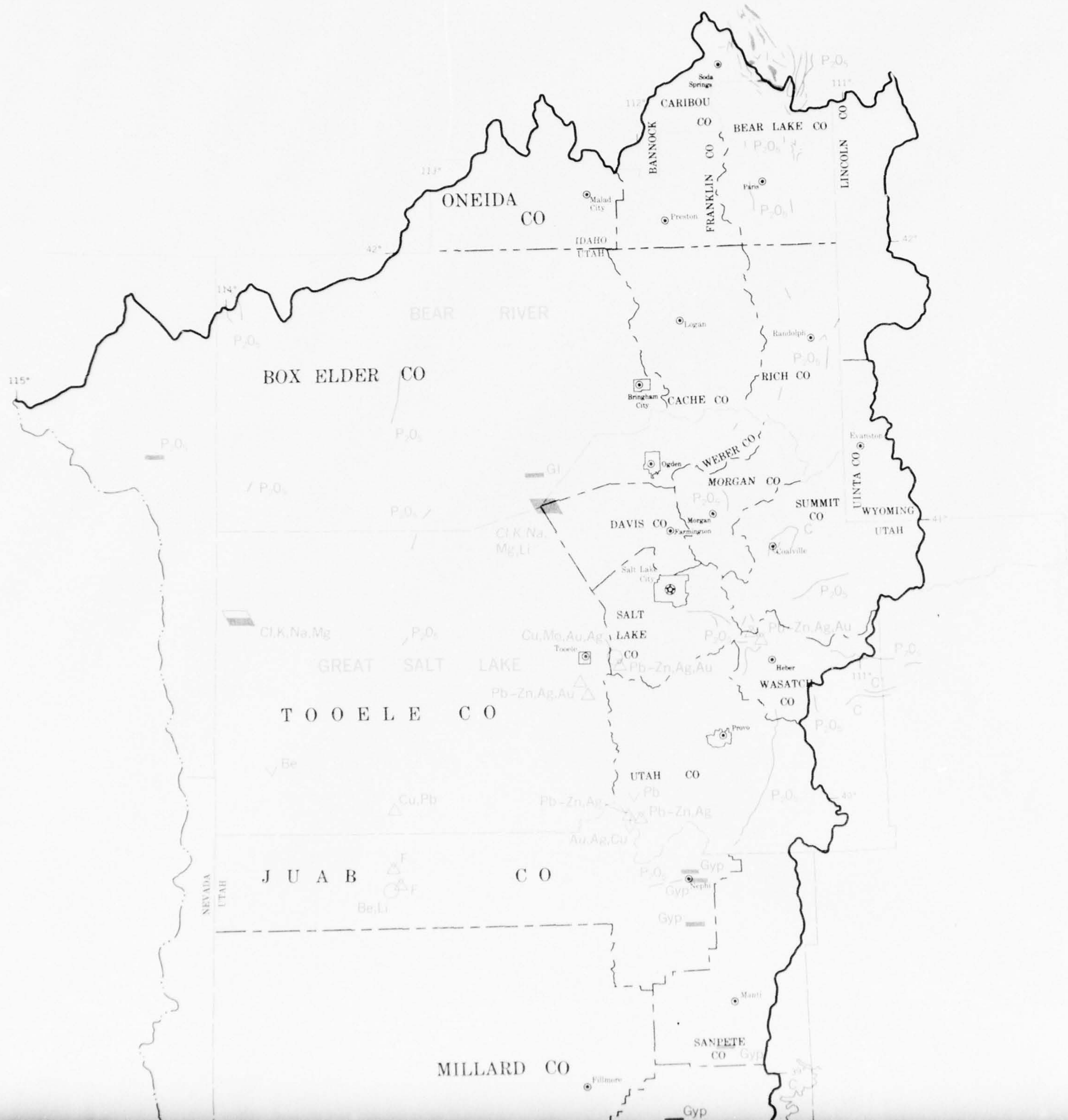
1/ Flood and sediment damage are also shown under Flood Control needs.

TABLE 11. WATERSHED TREATMENT NEEDS - FOREST AND RANGELANDS

		Great Basin Region						
Treatment	Unit	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Region
Water spreading	acre	0	1,400	100	4,700	12,800	6,100	25,100
Road & trail rehabilitation	mile	979	909	2,127	880	653	1,192	6,740
Streambank & lakeshore stabilization	mile	183	456	902	306	373	261	2,481
Sheet rill & gully erosion control	1,000 acre	11	221	249	32	82	68	663
Stabilization of dunes, blowouts, mines	acre	500	1,200	2,800	1,200	4,500	900	11,200
Tree planting (reforestation)	1,000 acre	49	14	72	0	3	6	144
Seeding	1,000 acre	92	564	528	711	82	426	2,403
Brush & weed control & type conversion	1,000 acre	3,450	570	425	1,758	62	370	3,735
Woodland site improvement	1,000 acre	39	26	289	2	6	9	371
Gully stabilization	mile	307	1,177	3,260	371	874	1,352	7,341
Sediment & debris basins	no.	50	0	744	105	44	37	980
Diversion structures	no.	36	290	1,301	95	39	299	2,060
Dike & levee	mile	184	1,812	1,173	556	57	195	3,977
Flood retarding	no.	10	74	78	60	9	2	233
Floodway	feet	0	0	10,000	0	0	0	10,000
Stream channel improvement	mile	14	16	12	40	62	30	174
Stockwater development (Wells, pipelines, springs, ponds, reservoirs)	no.	4,040	4,606	4,369	1,770	340	1,585	16,710
Fencing	mile	3,996	3,612	4,081	3,946	923	4,288	20,846

TABLE 12. WATERSHED TREATMENT NEEDS - IRRIGATED AND DRY CROPLAND

		Great Basin Region						
Treatment	Unit	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Region
Field ditches	1,000 acre	72	82	88	102	61	51	456
Land leveling	1,000 acre	229	207	195	129	91	43	894
Ditch lining	1,000 acre	74	74	98	21	24	10	301
Pipelines	1,000 acre	56	72	80	23	16	12	259
Irrigation structures	1,000 acre	78	89	104	41	51	41	404
Sprinkler systems	1,000 acre	92	136	118	40	43	17	446
Drainage	1,000 acre	143	61	20	50	35	4	313
Water spreading	1,000 acre	2.4	3	0.6	0.1	0.1	0	6.2
Contour farming	1,000 acre	1,000	290	30	0	0	0	1,320
Critical area planting	1,000 acre	2.1	6	1.5	0	0	0	9.6
Crop residue management & mulching	1,000 acre	683	481	195	0	0	16	1,375
Field windbreaks	mile	15	7	8	3	73	20	126
Hillside ditches	1,000 feet	40	120	30	0	0	0	190
Strip cropping	1,000 acre	13	121	2	0	0	0	136



ONEIDA CO
BANNOCK
CARIBOU CO
FRANKLIN CO
BEAR LAKE CO
LINCOLN CO
Soda Springs
Malad City
Preston
Paris
IDAHO
UTAH
BEAR RIVER
BOX ELDER CO
Logan
Randolph
RICH CO
Brigham City
CACHE CO
Evanston
UINTA CO
WYOMING
UTAH
Ogden
WEBER CO
MORGAN CO
SUMMIT CO
DAVIS CO
Morgan
Farmington
Coalville
Salt Lake City
SALT LAKE CO
Tooele
Heber
WASATCH CO
GREAT SALT LAKE
TOOELE CO
Provo
UTAH CO
JUAB CO
Nephi
NEVADA
UTAH
Manti
SANPETE CO
MILLARD CO
Fillmore
P_2O_5
Gl
Cl,K,Na,Mg,Li
Cl,K,Na,Mg
Cu,Mo,Au,Ag
Pb-Zn,Ag,Au
Be
Cu,Pb
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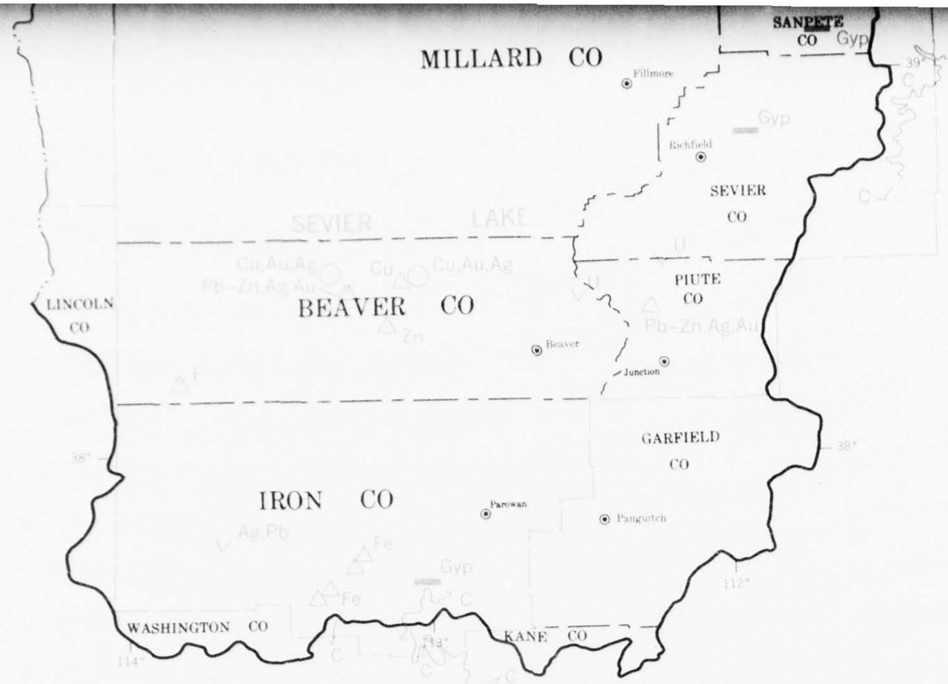

EXPLANATION

Outcrop of coal bed

Outcrop of phosphate rock

TYPES OF DEPOSITS

Disseminated

Replacement

Vein or replacement

Bedded

Vein

Subsurface brine

Surface brine

CONSTITUENTS

Ag-Silver	Cl-Chlorine	Gl-Glaubers' salt	Mo-Molybdenum	Pb-Lead
Au-Gold	Cu-Copper	Gyp-Gypsum	Mg-Magnesium	U-Uranium
Be-Beryllium	F-Fluorspar	K-Potassium	Na-Sodium	Zn-Zinc
C-Coal	Fe-Iron	Li-Lithium		

Hydrologic Subregion boundary between Eastern and Western Subregions

Economic boundaries

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

LOCALITIES, OUTCROPS, AND AREAS OF SIGNIFICANT KNOWN MINERAL RESOURCES


OREGON
NEVADA
CALIFORNIA
NEVADA
WASHOE CO
HUMBOLDT CO
PERSHING CO
ELKO CO
LANDER CO
EUREKA CO
WHITE PINE CO
CHURCHILL CO
STOREY CO
LYON CO
ORMSBY CO
DOUGLAS
MINERAL CO
NYE CO
HUMBOLDT
CENTRAL LAHONTAN
BARITE — BEARING BELT
TONOPAH
Winnemucca
Lovelock
Elko
Austin
Eureka
Ely
Fallon
Reno
Virginia City
Carson City
Yerington
Minden
Hawthorne
Tonopah
Oilfield
Hg
W
B-F
K-H
Gyp
Fe
Cu
Au
Ba
Mo
Mag
Cu,Ag,Au
Cu,Mo
Pb-Zn,Ag,Cu
Cu,Au,Ag
P_2O_5
Pb,Au,Ag
Zn-Pb,Ag
Pb,Ag,Au
Cu,Au,Ag,Mo,Pb-Zn
Cu,Ag,Pb-Zn
Be,W
Fe,Cu
Cu,Au,Ag
Pb-Zn,Ag
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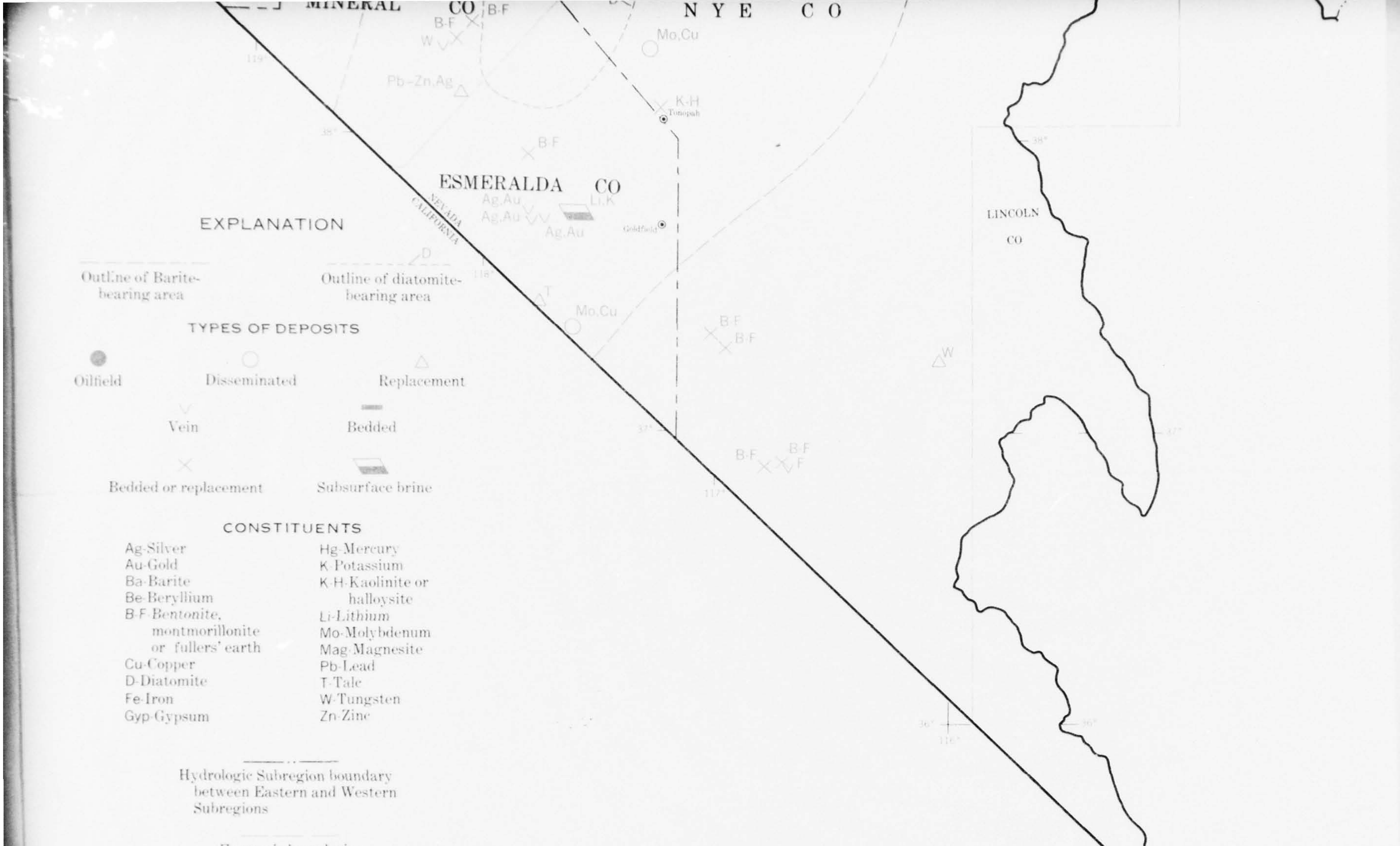


GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH APPROXIMATELY

1970

LOCALITIES, OUTCROPS, AND AREAS OF SIGNIFICANT KNOWN MINERAL RESOURCES

Flood Control

Flood damages in the past have not been excessive because of limited and sparse development. In recent years accelerated urbanization and more intensive use of agricultural areas have increased the economic burden of flood losses. As population and economic activity grow, recurring floods increase risk to life, human suffering and property damage unless adequate preventive measures are provided. Complete flood protection is an unrealistic goal due to the unpredictability of floods, the cost of protection and other uses of land and water resources that preclude complete flood protection.

Flood damages without additional flood control developments were projected as a measure of the future flood needs as shown in Table 13. Present damages have been divided into upstream cost, $2.2 million, and downstream cost, $3.1 million. Damage for future time frames will occur mainly in the downstream areas.

TABLE 13. FLOOD DAMAGES

Great Basin Region

Subregions	Estimated average annual cost 1965	1980	2000	2020
		($1,000)		
Bear River	507	735	1,127	1,792
Great Salt Lake	1,880	3,211	5,948	10,727
Sevier Lake	652	897	1,314	2,018
Humboldt	673	985	1,574	2,506
Central Lahontan	1,223	1,920	3,560	5,847
Tonopah	385	574	901	1,408
Region total	5,320	8,322	14,424	24,298

Irrigation and Drainage

Additional water is needed to supplement presently irrigated lands and to supply new lands. Withdrawal requirements increase 451,000 acre-feet and depletions 522,000 acre-feet by 2020. Irrigation efficiencies are expected to increase 5 percent by 2020. If 1965 efficiencies were maintained, withdrawal requirements would increase 1,250,000 acre-feet instead of 451,000 acre-feet at the projected efficiency.

About 15 percent of the irrigated lands in the Region would require some type of drainage facilities to maintain crop productivity. About 313,000 additional acres would require drainage by 2020.

Little change is needed in the total irrigated acreage although large acreages of new land need to be developed to replace those converted to other uses. To replace irrigated land lost to other uses, about 59,000 acres of idle improved land and 245,000 acres of dry cropland and rangeland will need to be developed for irrigation by 2020. Table 14 shows land use changes and development needed to meet projected requirements.

TABLE 14. IRRIGATED LAND REQUIREMENTS - REGIONAL SUMMARY

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously dev. land	2,114	2,114	2,104	2,098	-
Loss to other uses 1/	-	-65	-78	-96	-239
New land required 1/	-	55	72	118	+245
Net developed land	2,114	2,104	2,098	2,120	+ 6
Idle land remaining	116	122	79	57	+ 59 2/
Productive land	1,998	1,982	2,019	2,063	+ 65

1/ Values are incremental amounts.
2/ Idle land restored to production.

The above table assumes that various projected increases in crop yields would be realized. Because of the possibility of some restrictions on the use of fertilizers and pesticides, these yields may not be reached. To meet projected production at 1965, yield rates would require about 1.1 million additional acres of productive irrigated land. Diversion requirements would increase about an additional 4 MAF, based on 2020 projected efficiencies, and depletions an additional 1.9 MAF.

Municipal and Industrial Water

Municipal and industrial water withdrawal requirements are projected to increase from 493,000 acre-feet in 1965 to about 1,872,000 acre-feet by the year 2020. The depletions would increase from 161,000 acre-feet to 871,000 acre-feet during the same period. Industrial withdrawal requirements are projected to increase from 38 percent of the total withdrawals in 1965 to 49 percent in 2020. Depletions increase from 24 percent to 56 percent in the same period. Important factors used in making the projections were projected population data, historic trends reflecting increased water use per capita, employment projections and associated economic activities, and the trend of increased recirculation in industrial use. The intake requirements reflect recycling within specific industries but do not reflect reuse of municipal or industrial water.

Municipal and some industrial use will require water of sufficient quality to meet acceptable standards. In addition to initial water treatment, effluent treatment would be required to permit reuse.

Outdoor Recreation

Outdoor recreation demand is based primarily on the historical trends of participation in selected recreation activities. The projected recreation demand, particularly in the western subregions, originates primarily from large urban areas outside the Region.

Water-based recreation demand was estimated to be 20 million recreation days in 1965. This represents 30 percent of the total demand. The 2020 water-based demand would be 118 million recreation days. Water surface acreage required to meet the recreation demand is tabulated in Table 15. Water diversion and depletion requirements for culinary needs only are shown in Table 8, page 29.

TABLE 15. RECREATION WATER SURFACE REQUIREMENTS

Great Basin Region

Subregion	1965	1980	2000	2020
		(Acres)		
Bear River	7,410	11,873	21,749	34,586
Great Salt Lake	10,795	23,161	44,389	77,196
Sevier Lake	5,097	8,073	14,030	21,132
Humboldt	3,394	5,776	9,753	14,963
Central Lahontan	7,612	13,309	23,981	38,826
Tonopah	6,699	13,054	26,854	40,832
Region	41,007	75,246	140,756	227,535

Land acreage required to meet recreation demands is shown in Table 16. The future needs for recreation Class I and II lands near urban areas are not included. Acquisition of these lands by public entities or the use of these lands through private inducement would be a necessity. Part of the demand for Class IV and V lands is included in the demand for Class III land because suitable land in these classes is lacking. The total demand for recreation land equals about one-half of the total land areas of the Region. Most of this demand is for recreation Class III and V land which could accommodate multiple uses.

TABLE 16. RECREATION LAND ACREAGE REQUIREMENTS

Great Basin Region

Subregion by target year	Recreational classes					
	Class I	Class II	Class III	Class IV	Class V	Total
			(Acres)			
Bear River						
1965	490	4,280	417,900	43,380	687,870	1,153,920
1980	780	6,870	669,530	70,000	1,100,000	1,847,180
2000	1,290	12,610	1,229,530	128,800	2,021,210	3,393,440
2020	2,070	20,050	1,955,110	204,600	3,212,100	5,393,930
Great Salt Lake						
1965	3,890	8,140	1,003,230	75,300	1,131,570	2,222,130
1980	8,280	17,580	2,168,230	148,180	2,447,360	4,789,630
2000	16,660	33,590	4,145,800	238,000	4,676,300	9,110,350
2020	28,900	58,560	7,222,300	397,100	8,147,300	15,854,160
Sevier Lake						
1965	280	3,390	384,590	7,490	344,230	739,980
1980	400	5,380	610,270	11,900	548,070	1,176,020
2000	510	9,400	1,065,400	20,780	955,760	2,051,850
2020	570	14,200	1,610,000	31,390	1,444,230	3,100,390
Humboldt						
1965	140	1,270	157,060	9,290	239,290	407,050
1980	220	2,170	267,650	15,860	410,710	696,610
2000	310	3,680	453,520	26,860	692,850	1,177,220
2020	410	5,660	697,640	41,290	1,067,850	1,812,850
Central Lahontan						
1965	790	6,270	730,550	60,380	948,570	1,746,560
1980	1,780	10,870	1,266,110	111,000	1,642,850	3,032,610
2000	3,850	19,430	2,263,880	198,400	2,937,100	5,422,660
2020	7,110	31,260	3,641,100	319,200	4,722,800	8,721,470
Tonopah						
1965	90	2,560	315,000	26,000	675,000	1,018,650
1980	160	4,980	614,110	50,800	1,315,000	1,985,050
2000	300	10,260	1,264,700	104,800	2,710,000	4,090,060
2020	470	18,670	2,302,050	190,800	4,935,000	7,446,990
Region						
1965	5,680	25,910	3,008,330	221,840	4,026,530	7,288,290
1980	11,620	47,850	5,595,900	407,740	7,463,990	13,527,100
2000	22,920	88,970	10,422,830	717,640	13,993,220	25,245,580
2020	39,530	148,400	17,428,200	1,184,380	23,529,280	42,329,790

TABLE 17. RECREATION DEMAND

Great Basin Region

Subregion by target year	Class I	Class II	Class III	Class IV	Class V	Total
	(1,000 recreation days)					
Bear River						
1965	1,563	5,570	1,797	219	227	9,376
1980	2,497	8,925	2,879	350	363	15,014
2000	4,127	16,391	5,287	644	667	27,116
2020	6,622	26,060	8,407	1,023	1,060	43,172
Great Salt Lake						
1965	14,041	10,576	3,411	415	430	28,873
1980	28,082	22,854	7,372	998	930	60,236
2000	54,883	43,670	14,096	1,716	1,777	116,142
2020	94,093	76,124	24,556	2,989	3,096	200,858
Sevier Lake						
1965	884	4,411	1,423	173	179	7,070
1980	1,272	7,000	2,258	275	285	11,090
2000	1,641	12,218	3,942	480	497	18,778
2020	1,819	18,466	5,957	725	751	27,718
Humboldt						
1965	434	1,655	534	65	67	2,755
1980	694	2,821	910	111	115	4,651
2000	996	4,780	1,542	188	194	7,700
2020	1,306	7,354	2,372	289	299	11,620
Central Lahontan						
1965	2,520	8,153	2,630	320	332	13,955
1980	5,704	14,128	4,558	555	575	25,520
2000	12,316	25,264	8,150	992	1,028	47,750
2020	22,748	40,636	13,108	1,596	1,653	79,741
Tonopah						
1965	290	3,320	1,071	130	135	4,946
1980	527	6,474	2,088	254	263	9,606
2000	951	13,332	4,300	524	542	19,649
2020	1,499	24,265	7,827	953	987	35,531
Region						
1965	19,731	33,685	10,866	1,323	1,370	66,975
1980	38,776	62,202	20,065	2,543	2,531	126,117
2000	74,915	115,655	37,317	4,543	4,705	237,135
2020	128,087	192,905	62,227	7,575	7,846	398,640

Class I - High density recreation areas. Areas intensively developed and managed for mass use.

Class II - General outdoor recreation areas. Areas subject to substantial development for a wide variety of specific recreation uses.

Class III - Natural environment areas. Various types of areas that are suitable for recreation in a natural environment and usually in combination with other uses.

Class IV - Unique natural areas. Areas of outstanding scenic spendor, natural wonder or scientific importance.

Class V - Primitive areas. Undisturbed roadless areas characterized by natural wild conditions, including "wilderness areas".

Fish and Wildlife

As the human population increases and becomes more concentrated in large urban areas, the per capita rate of fishing and hunting tends to decline. However, this decline is likely to be offset by increasing public interest in other forms of wildlife related recreation. Therefore, projection of demands in proportion to human population appears to provide a reasonable indication of future needs even though a significant portion of future demands may be met in forms other than hunting or fishing. Tables 18 and 19 show projected fishing and hunting demands.

TABLE 18. FISHING DEMAND

Great Basin Region

Type of fishing	1965	1980	2000	2020
	(1,000 fisherman-days)			
Coldwater				
Idaho	116	120	150	200
Nevada	231	294	428	620
Utah	1,272	1,572	2,148	2,889
Wyoming	12	12	15	20
Subtotal	1,631	1,998	2,741	3,729
Warmwater				
Idaho	10	10	13	17
Nevada	31	36	49	66
Utah	100	131	185	254
Wyoming	0	0	0	0
Subtotal	141	177	247	337
All fishing				
Idaho	126	130	163	217
Nevada	262	330	477	686
Utah	1,372	1,703	2,333	3,143
Wyoming	12	12	15	20
Total	1,772	2,175	2,988	4,066

TABLE 19. SPORT HUNTING DEMAND

Great Basin Region

Type of hunting	1965	1980	2000	2020
		(1,000 hunting days)		
Big game				
Idaho	44	45	57	77
Nevada	169	198	270	362
Utah	409	510	677	883
Wyoming	18	18	23	30
Subtotal	640	771	1,027	1,352
Small game				
Idaho	19	20	25	44
Nevada	150	174	230	306
Utah	283	363	507	689
Wyoming	3	3	4	5
Subtotal	455	560	766	1,044
Waterfowl				
Idaho	5	5	6	7
Nevada	13	15	21	29
Utah	200	270	389	537
Wyoming	1	1	1	2
Subtotal	219	291	417	575
All hunting				
Idaho	68	70	88	128
Nevada	332	387	521	697
Utah	892	1,143	1,573	2,109
Wyoming	22	22	28	37
Total	1,314	1,622	2,210	2,971

Mitigation of losses to fishing, due to inundation of prime stream segments by new reservoirs, would be needed. Intensive management and protection of remaining suitable stream habitat in the mountain reaches would also be required. Preservation of existing game and waterfowl habitat is essential to meet projected demands.

Electric Power

The demand for electric generating capacity is projected to reach about 33,000 mw by the year 2020, or more than 30 times the installed capacity in 1965, and the energy load about 160,000 gwh with 46,000 gwh imported. Table 20 shows the projected electric power requirements.

TABLE 20. ELECTRIC POWER REQUIREMENTS

Great Basin Region

	1965	1980	2000	2020	Increase 1965-2020
			(Megawatts)		
Capacity					
Eastern subregions	800	2,600	9,500	24,000	23,200
Western subregions	200	840	3,500	9,420	9,220
Total	1,000	3,440	13,000	33,420	32,420
			(Gigawatt-hours)		
Energy					
Eastern subregions	4,300	12,720	46,900	117,000	112,700
Western subregions	1,200	3,760	16,200	43,200	42,000
Total	5,500	16,480	63,100	160,200	154,700

New fossil-fueled and nuclear stream-electric plants are projected to increase the annual consumptive use of water from 7,000 acre-feet in 1965 to about 124,000 acre-feet in 2020. Table 8, page 29 shows the projected water requirements for thermal plants. Pumped storage hydro-electric facilities are primarily used for peaking purposes and can then utilize storage developed for other purposes. Greater utilization of geothermal energy could take place in the near future because of environmental advantages, relatively low cost, and expected technological advancements. Two plants, totaling 340 mw capacity, are projected to be built between 2000 and 2020 in the western subregions. The Region contains many other sites with potential for geothermal production.

Projected land requirements for electric facilities are expected to increase from 46,600 acres to 137,000 acres by 2020.

Water Quality, Pollution Control and Health Factors

The greatest challenges to water quality management may not be those of a technical nature, but could be the constraints imposed by existing legal and institutional arrangements. Any future water management program must incorporate a consideration of the impact of water quality problems on development, and the impact of development on water quality. The search for solutions to these problems must include an examination of existing legal systems and of institutional arrangements, to determine their efficacy in implementing plans for the management of water quantity and quality.

The difficulty of maintaining or restoring water quality is continually increasing because of the growing quantity of pollutants. Increases in pollution loads result not only from population growth and industrial expansion, but also from increased water and land uses. Although many situations can be met with existing knowledge, there is a continuing need for better basic technological data, improvements in waste removal, treatment methods, and erosion and sedimentation control measures. In addition, research and demonstration efforts are needed to develop effective control measures.

Present health programs need to be expanded to provide better protection of the public health. There is a need for continuous and close liaison and cooperation between public health agencies and those concerned with the development and use of water and land resources from the early planning stages through construction and operation of projects. This includes improved management regarding surface and ground-water pollution, pesticide use, thermal pollution, solid waste disposal, disease vector control, and air and radiological pollution.

The major pollution problems occur in three general areas. These are the Wasatch Front area of Great Salt Lake Subregion, the Central Lahontan Subregion and portions of the Sevier Lake Subregion.

Residual wastes from secondary treatment plants overtax the assimilative capacity of the Jordan River. Pollution of Utah Lake presents health hazards that restrict recreational use. Decreasing inflows, with increasing amounts of pollutants, create problems in the Great Salt Lake.

The Truckee River below the Reno-Sparks area exceeds Nevada's nutrient standards. The Carson River contains excessive nutrients derived primarily from local sources. Pyramid and Walker Lakes are experiencing increasing salinity levels due to irrigation return flows, decreased inflows and declining water levels. Excessive aquatic plant growth due to high nutrient content, occurs in Lahontan Reservoir. In the Lake Tahoe basin, development and associated erosion of frail lands cause increased nutrient and sediment problems in the lake.

The primary water quality problem in the Sevier Lake Subregion is the increasing salinity of Sevier River and some ground-water reservoirs. More intensive use and reuse would increase salt load concentrations. Erosion and sedimentation are also pollution problems.

If the present trend continues, untreated municipal and industrial wasteloads as measured by BOD (biochemical oxygen demand) would double during the 1965 to 2020 period. In the Great Salt Lake Subregion, this wasteload would comprise about two-thirds of the regional BOD by 2020.

Terminal Lakes

In recent years, interest in recreation and in conservation of natural environment has increased the concern for preserving terminal lakes. The three main perennial terminal lakes are Pyramid and Walker Lakes in Nevada, and Great Salt Lake in Utah. In order to understand the difficulty of maintaining these lakes, it is necessary to understand the sensitive balance nature has imposed on them. These lakes are at the ends of perennial streams. Climatic variations and upstream depletions cause inflow to vary widely from year to year. This in turn results in fluctuations in lake levels to maintain equilibrium between inflow and evaporation.

The net annual evaporation rate, total evaporation less precipitation is 3.4 feet on Pyramid Lake and 3.8 feet on Walker Lake. During the period 1931 to 1960, Pyramid Lake declined 41.4 feet, an average of 1.38 feet per year. For the same period, Walker Lake declined 58.8 feet for an average of 1.96 feet per year. As an indication of their sensitivity to climatic conditions, both lakes rose about 8 feet during 1969, a high runoff year.

In contrast to Pyramid and Walker Lakes, Great Salt Lake covers a large area and is very shallow. Changes in inflow are accompanied by large changes in volume and surface area with only small changes in depth. During the period 1931 to 1960, the lake has declined about 6 feet. The surface area decreased about 400,000 acres and the volume 5 MAF.

There are some functions such as recreation, wildlife habitat, and mineral recovery in the Great Salt Lake which would benefit by maintaining lake stages at or near some selected level. The estimated water requirements to maintain these terminal lakes at various levels are given in Table 21. For example, to maintain the terminal lakes at 1965 levels would require increased inflows of 0.3 MAF to Great Salt Lake, 0.13 MAF to Pyramid Lake, and 0.07 MAF to Walker Lake. These inflows are in addition to the 1931-1960 average inflows modified to 1965 levels of development.

TABLE 21. ESTIMATED WATER REQUIREMENTS TO MAINTAIN PRINCIPAL TERMINAL LAKES AT VARIOUS LEVELS

Great Basin Region

Lake stage (MSL)	Decline from 1965 level (feet)	Required river inflow (1000 af/yr)	Volume (maf)	Area (1000 acres)	Dissolved solids content (mg/l)	Time 1/ (years)
			Great Salt Lake			
4,193.75	0	1,792	10.2	670	290,000 2/	0
4,189.3	4.5	1,500 3/	7.6	562		18
4,182.7	11.6	1,200	3.9	451		22
4,177.4	16.4	900	2.0	340		19
4,173.6	20.2	600	0.9	229		16
4,170.0	23.8	370.5	0.25	118		14
			Pyramid Lake			
3,788.5	0	365	20.3	108	5,700	0
3,754.0	34.5	338	16.9	100	6,100	264
3,690	98	290	11.0	85	6,900	260
3,645	143	240.5 3/	7.4	71	7,900	259
3,583	205	170	3.7	51	10,000	171
3,551	237	140	2.2	42	12,000	163
			Walker Lake			
3,972.7	0	147	3.1	39	9,500	0
3,900	73	81 3/	0.5	22	23,000	83
3,868	105	50	0.1	14	94,000	64
3,862	111	37	0.05	11	190,000	58
3,860	113	32	0.03	9	saturation	55

1/ Time required to reach indicated lake stage from 1965 stage.
2/ 1960-66 weighted average of the south arm of the lake.
3/ Inflow value for 1931-60 reference period, modified to 1965 level of development.

Environment

A basic objective of this study is the conservation and preservation of resources to insure their continued availability. The protection of future development opportunities and of natural and cultural values is essential. When several resources occur in a common area, their development and use may be in conflict, and planning is necessary for their most effective utilization. The condition of all resources and the various changes man has placed on them, determine present quality and future needs of the environment.

A critical air quality problem has developed along the Wasatch Front because of man-caused pollution compounded by natural temperature inversions. All development should utilize improved municipal and industrial pollution controls in all areas.

Water resources are an important part of the environment. Development and use of this resource requires improvement and control to insure a high level of quality. The strict control of sewage effluents and solid wastes in the Lake Tahoe basin exemplifies means of reducing nutrients entering the lake. However, additional measures are needed to control other sources of pollution.

Open space is necessary in urban as well as rural areas to maintain a pleasing environment. Urban development should be planned to include open space and greenbelt areas. Agricultural lands presently provide open space in some areas and should be preserved. Stream channels and flood plains, such as Jordan and Truckee Rivers, should be used as greenbelt recreation areas.

Other environmental needs include preservation and protection of scenic, wilderness, and historic areas, free-flowing streams, scenic roads and trails, and rare and endangered plant and animal species.

It is not possible to foresee all environmental conflicts, impacts, or benefits at this level of planning. When project planning is initiated, these aspects must be investigated. The most significant need is to recognize that no land use or water development can occur without impact on the environment.

PART IV

RESOURCE AVAILABILITY

The Region contains a wide variety of resources, however, their utilization is dependent upon other factors. In some cases, the dispersal of the resource over large areas or occurrence in remote areas limits economical use. For example, large areas of good land are available but are restricted for some uses by limited water supplies. The physical occurrence, legal and institutional constraints, and economics limit the reasonable availability of most resources.

Water Resources

The average annual precipitation for the Region is about 11 inches. The estimated total volume of precipitation is 82 MAF (million acre-feet), about equally divided between the eastern and western subregions. More than 90 percent of the volume of precipitation is used by evaporation and transpiration without becoming streamflow or ground-water recharge.

Water Supply

The renewable water supply is the water resource identifiable as streamflow and ground-water discharge. Streamflow consists of gaged flow at selected stations on the principal streams, depletions upstream from these gaging stations and flow of secondary and minor streams below the gaging stations. Natural ground-water discharge is the estimated discharge in areas downstream from the principal stream gaging stations. The combined Regional water supply of about 9.6 MAF represents an average quantity. The actual supply varies seasonally and from year to year. Table 22 shows the nominal annual water supply.

The nominal water supply, less the depletions for the 1965 level of identified uses, is the residual supply remaining to meet future uses. Table 23 summarizes the residual supply.

Large quantities of water are stored in natural lakes, and surface and ground-water reservoirs. This supply is available on a one-time basis only. Natural ground-water and lake storage supplies may require treatment, depending on the use, if considered as a source of supply to meet future needs. Table 24 shows the quantity of water in storage in 1965, including active reservoir storage.

TABLE 22. NOMINAL ANNUAL WATER SUPPLY[1/]

Great Basin Region

Subregion	Streamflow	Natural ground-water discharge	Combined water supply
	(1,000 acre-feet annually)		
Bear River	2,090[2/]	40	2,130
Great Salt Lake	1,914[3/]	630	2,544
Sevier Lake	912[4/]	328	1,240
Humboldt	854	480	1,334
Central Lahontan	1,228[5/]	104	1,332
Tonopah	290	680	970
Region	7,288	2,262	9,550

1/ Includes all 1965 uses.
2/ Excludes 10,000 acre-feet export to Columbia North Pacific Region.
3/ Includes 99,000 acre-feet imports from Upper Colorado Region.
4/ Includes 9,000 acre-feet net imports from Upper Colorado Region.
5/ Includes 1,120,000 acre-feet inflow from California Region.

TABLE 23. ANNUAL RESIDUAL WATER SUPPLY

Great Basin Region

Subregion	Streamflow	Natural ground-water discharge	Combined supply
	(1,000 acre-feet annually)		
Bear River	755	-	755
Great Salt Lake	618	289	907
Sevier Lake	64	222	286
Humboldt	239	394	633
Central Lahontan	357	57	414
Tonopah	152	487	639
Region	2,185	1,449	3,634

TABLE 24. AVAILABLE GROUND-WATER, LAKE AND RESERVOIR STORAGE - 1965

Great Basin Region

Subregion	Lake and reservoir storage	Ground-water reservoir storage[1/]	Combined storage
	(1,000,000 acre-feet)		
Bear River	6.0[2/]	12.0	18.0
Great Salt Lake	12.2[3/]	50.0	62.2
Sevier Lake	0.2	22.0	22.2
Humboldt	0.3	44.0	44.3
Central Lahontan	24.2[4/]	16.0	40.2
Tonopah	0.1	50.0	50.1
Region	43.0	194.0	237.0

1/ Estimated amount in the upper 100 feet of saturated deposits.
2/ Includes 4.66 MAF of unregulated storage in Bear Lake.
3/ Includes 10.6 MAF in Great Salt Lake.
4/ Includes 23.56 MAF in Pyramid and Walker Lakes but not the Nevada part of Lake Tahoe.

Water Availability

This section considers the reasonable availability of water in particular reference to its physical occurrence. As pollution control becomes more fully established, it may be assumed that water deteriorated from man's use would be adequately treated to meet requirements. Reference in this section to treatment for quality improvement primarily relates to removal of naturally occurring salts.

Availability, as estimated in Table 25 represents part of the residual water supply after the 1965 level of use is subtracted. A simple summation of all items in the table does not define the total availability. Rather, availability is somewhat less because some items are available only at the expense of another item. For example, further development of principal streamflow would reduce inflow to the terminal lakes. In turn, this would result in a higher proportion of terminal lake storage being lost by direct evaporation. In effect, then, various combinations of the items in the table can be considered in determining a reasonable means of supplying the projected needs under the framework plan.

Evaluation of the elements of the residual water supply indicates that 50 percent, about 1.8 MAF annually, of the 3.6 MAF supply may be available. This includes approximately 1.2 MAF from streamflow and 0.6 MAF from ground water. The remaining 1.8 MAF is considered unavailable due to difficulty of salvaging scattered water supply and variations in quantity from the average annual supply.

The following are elements of supply that are available through salvage. Improved water management and ground-water withdrawals in the upstream depletion areas of the principal stream systems might yield 0.3 MAF of additional water. Improvement of quality could permit development of an additional 0.4 MAF of ground water. Evaporation reduction from Utah Lake by diking should reduce evaporation by about 0.07 MAF.

Reuse of water to meet withdrawal requirements downstream from the control gaging stations of the principal streams is about 0.5 MAF. Imports from the Upper and Lower Colorado Regions could be increased about 0.37 MAF. The actual increase to this Region would depend on the choice by Utah of the places of use for its share of Colorado River water.

The annual yield from one-time ground-water storage over a 50-year period could be 1.4 MAF without treatment and 1.0 MAF with treatment. About 0.8 MAF of water stored in the terminal lakes is physically available with treatment and represents an annual rate for 50 years, based on the volume in storage as of the end of the 1965 water year. Diking of Great Salt Lake could reduce evaporation loss by about 0.6 MAF annually. This can be accomplished by improved water management, additional ground-water development, and conjunctive use.

TABLE 25. AVAILABILITY OF WATER TO MEET PROJECTED USES

Elements of supply	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Great Basin Region Region
			(Millions of acre-feet)				
Residual water supply	0.6	0.48	0.09	0.22	0.15	0.24	1.8
Salvage of water:							
Improved management, upstream depletion areas	0.12	0.1	0.06	0.04	0.04	-	0.3
Improvement of quality from natural ground-water discharge	-	0.06	0.06	0.1	0.01	0.12	0.4
Evaporation reduction from Utah Lake	-	0.07	-	-	-	-	0.07
For withdrawal only:							
Reuse	0.17	0.1	0.03	0.05	0.22	-	0.6
Net imports from Upper and Lower Colorado Regions	-	0.29	0.08	-	-	-	0.37
Time-limited supply: 1/							
Ground-water storage reserve;							
Without treatment	0.1	0.2	0.1	0.4	0.05	0.5	1.4
With treatment	0.1	0.2	0.1	0.2	0.05	0.3	1.0
Terminal lake storage, with treatment	-	0.2	-	-	0.56	-	0.8
Potential augmentation:							
By precipitation management	0.37	0.31	0.08	0.06	0.04	0.05	0.9
Vegetation manipulation	-	-	-	-	-	-	0.04
Conversion of ocean water	-	-	-	-	0.3	-	0.3
To offset other depletions:							
Evaporation reduction, Great Salt Lake	0.6	-	-	-	-	-	0.6

1/ Annual amount for 50-year period.

The annual water supply could be augmented by about 0.9 MAF through precipitation management. Augmentation of water supply is possible by manipulation of vegetation. This quantity is estimated at 0.04 MAF for the Region.

Each of these supplies would present some problems, if developed. Further development of the secondary and minor streams must be able to accommodate the wide geographic distribution of these streams and existing water rights. The relatively small size of the individual streams limits the possibility of more than seasonal storage. Development of ground water should be widely distributed to obtain the optimum sustained yield from the many valley ground-water reservoirs. Planned extensive development of one-time ground-water storage may require adjustments of legal and administrative constraints. Utilization of the water stored in the terminal lakes, for other purposes, would be at the expense of maintaining them. Augmentation of the water supply by precipitation management and vegetation manipulation may present legal and environmental problems. The use of desalted ocean water would require solutions to significant problems.

All these elements of water supply are available at costs approaching $500 per acre-foot. Selection of the particular combination of elements of supply and proportion of each, is dependent on the location of needs, costs, legal and institutional constraints, and political decisions.

Land Resource

Land available for various uses is shown by subregions in Table 26. Most land is suitable and available for more than one use; therefore, the values are not additive. Land suitability for food and fiber production is shown on the maps following page 49.

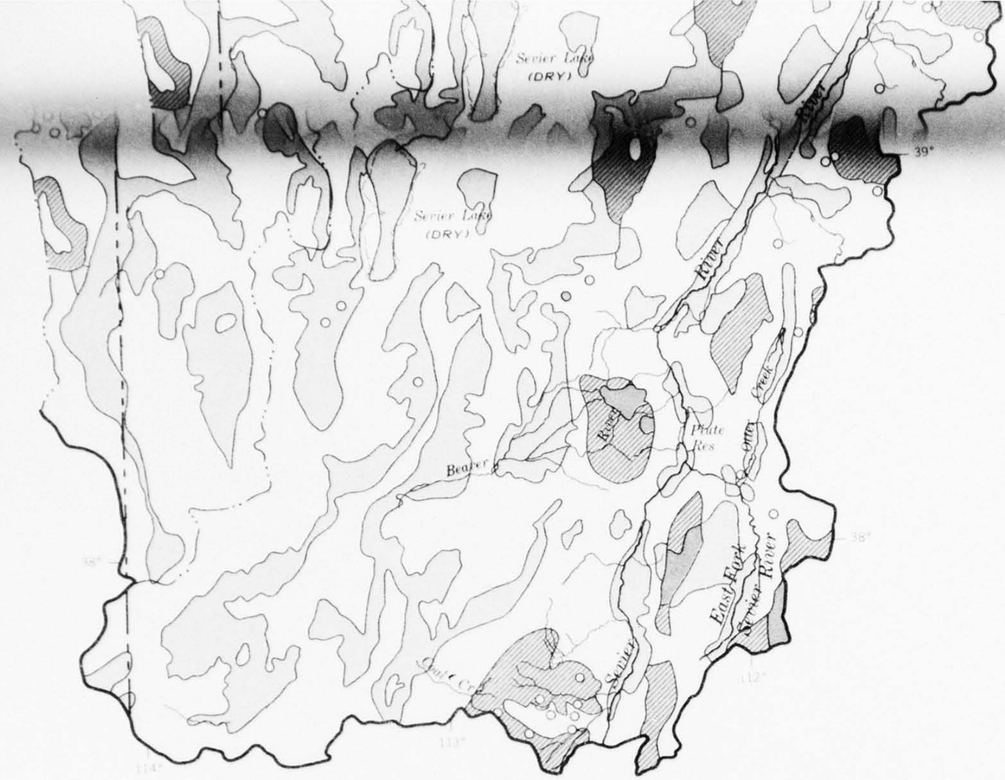
TABLE 26. LAND AVAILABLE FOR VARIOUS USES - 1965

Great Basin Region

Principal use	Bear River	Great Salt Lake	Sevier	Humboldt	Central Lahontan	Tonopah	Region
				(1,000 Acres)			
Irrigated cropland	1,193	2,705	2,145	3,603	658	4,152	14,456
Dry cropland	590	434	158	0	0	0	1,182
Grazing land	3,213	12,480	8,004	15,641	3,668	20,232	63,238
Timber	373	1,093	777	0	80	29	2,352
Outdoor recreation	35	92	82	70	10	141	430
Wilderness and scenic	45	127	53	73	232	420	950
Minerals 1/	227	2,894	1,838	4,181	2,593	4,709	16,442
Classified watershed	97	184	79	70	118	60	608

1/ Land under mineral claims

BEAR
RIVER
GREAT
SALT
LAKE
GREAT
SALT
LAKE
SEVIER
LAKE
Military withdrawal
UTAH LAKE
Bear Lake
Cutler Res
Jordan R
Weber
Gunnison Bend Res
Sevier Bridge Reservoir
Thousand Springs Cr
IDAHO
UTAH
NEVADA



EXPLANATION

Suitable for irrigation and grazing. At least 50 percent of area is arable

Suitable for irrigation and grazing; area less than 2,000 acres

Suitable for irrigation, dry farming and grazing. At least 50 percent of area is arable

Generally suitable for grazing

Suitable for timber production. At least 50 percent of area generally is suitable for commercial timber. See Vegetal Cover map for pinyon-juniper areas

Suitable for timber production and grazing. At least 50 percent of area generally is suitable for commercial timber. See Vegetal Cover map for pinyon-juniper areas

Other land, areas. Includes barren, critical areas, and water surface

Other land; mostly barren; less than 2,000 acres

Military withdrawal boundary

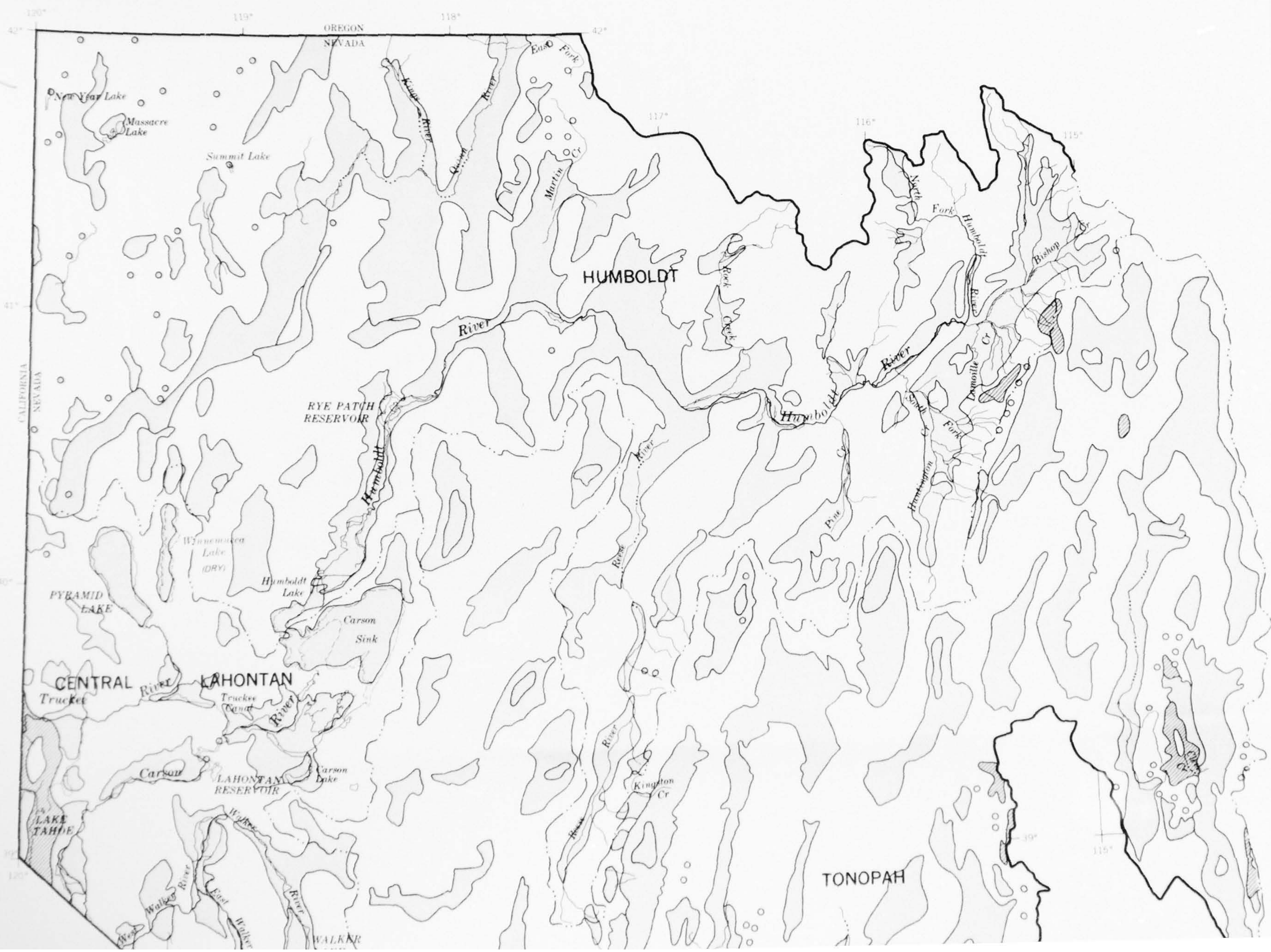
Boundary of hydrologic subregions

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970



OREGON
NEVADA
CALIFORNIA
NEVADA
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
New Year Lake
Massacre Lake
Summit Lake
Kings River
Quinn River
East Fork
Martin Cr
Rock Creek
North Fork
Humboldt River
Bishop Cr
Lamoille Cr
South Fork
Huntington Cr
Pine Cr
Reese River
Kingston Cr
RYE PATCH RESERVOIR
Winnemucca Lake (DRY)
Humboldt Lake
Carson Sink
PYRAMID LAKE
Truckee River
Truckee Canal
Carson River
Carson Lake
LAHONTAN RESERVOIR
LAKE TAHOE
Walker River
West Walker River
East Walker River
WALKER
120°
119°
118°
117°
116°
115°
42°
41°
40°
39°

EXPLANATION

Suitable for irrigation and grazing. At least 50 percent of area is arable

Suitable for irrigation and grazing; area less than 2,000 acres

Suitable for irrigation, dry farming, and grazing. At least 50 percent of area is arable

Generally suitable for grazing

Suitable for timber production. At least 50 percent of area generally is suitable for commercial timber. See Vegetal Cover map for pinyon-juniper areas

Suitable for timber production and grazing. At least 50 percent of area *generally is suitable for commercial* timber. See Vegetal Cover map for pinyon-juniper areas

Other land, areas. Includes barren, *critical areas, and water surface*

Other land; mostly barren; less than 2,000 acres

Military withdrawal boundary

Boundary of hydrologic subregions

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

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32 MILES TO THE INCH, APPROXIMATELY

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Cropland

The Region contains over 12 million additional acres of available and potentially irrigable land. These are available principally from areas presently used for dry cropland and grazing. Diversion requirements would exceed 53 million acre-feet at projected irrigation efficiencies. Approximately 24 million acre-feet of water would be depleted to fully supply these lands. There are about 1.2 million acres of land available for dry cropland all in the eastern subregions. About 90 percent of this is being farmed.

Grazing Land

About 75 percent of the land in the Region is available and used for livestock grazing. Some crop aftermath grazing is available on cropland in addition to this. Production on grazing land is expressed in terms of animal unit months (AUMs) of forage. Range forage can be increased by 3.2 million AUMs through range treatment and management. This amounts to a 79-percent potential increase over the 1965 production. Table 27 shows present and potential production on grazing land.

TABLE 27. POTENTIAL RANGE FORAGE PRODUCTION

Great Basin Region

Subregions	1965 production	Potential production	Percent increase
		(1,000 AUMs)	
Bear River	535	953	78
Great Salt Lake	907	1,642	81
Sevier Lake	719	1,222	70
Humboldt	1,002	2,085	108
Central Lahontan	232	353	52
Tonopah	704	1,075	53
Total	4,099	7,330	79

Forest Land

Presently there are 2.4 million acres of forest land suitable and available for commercial timber production. These lands are extremely important for watershed protection, wildlife habitat, recreation use, and esthetic values. Some lands, for example the 29,000 acres of commercial timber in the Tonopah Subregion, are probably more valuable for watershed and recreation than for timber production.

The present and potential timber production is shown in Table The hardwood (aspen) component is 34 percent of the total volume. Varieties of spruce, fir and pine make up most of the remaining vol Both net annual growth and harvest can be increased by 2020, but to resources will decline. This decline is attributable to harvest be greater than growth over the past few decades. Reduction in commer forest area also contributes to the decline.

TABLE 28. POTENTIAL TIMBER PRODUCTION

Great Basin F

Economic subregion	Land suitable and available for timber production	Present (1965) production	Potent produc
	(1,000 acres)	(Million cubic feet)	(Mill cubic
Bear River	373	0.177	9.
Great Salt Lake	1,093	2.033	22.
Sevier Lake	777	0.372	21.
Humboldt	0	0	
Central Lahontan1/	80	0	
Tonopah	29	.018	0.
Total	2,352	2.6	54.

1/ Potential timber production is not shown because land will be us for recreation and watersheds.

Minerals

Unlike most other resources, minerals are nonrenewable; their availability is dependent on discovery and economics, which in turn depend on quality of the deposit and technology.

The available known and predicted additional mineral resources considered are those occurring in large enough volume or value that they are mined at present or have development potential. These inc a wide variety of both metallic and nonmetallic minerals. The maps following page 51 show the location of the known mineral resources. following examples indicate the magnitude of some of these resource

About 3.3 billion tons of bituminous coal resources are locate several fields in Utah. About 45 million tons of known and predict lead, zinc, copper, and gold and silver ore are found in veins and placement deposits, about 75 percent of which occur in the Great Sa Lake Subregion. There are about 3 billion tons of porphyry type or that are about equally classified in known and predicted categories

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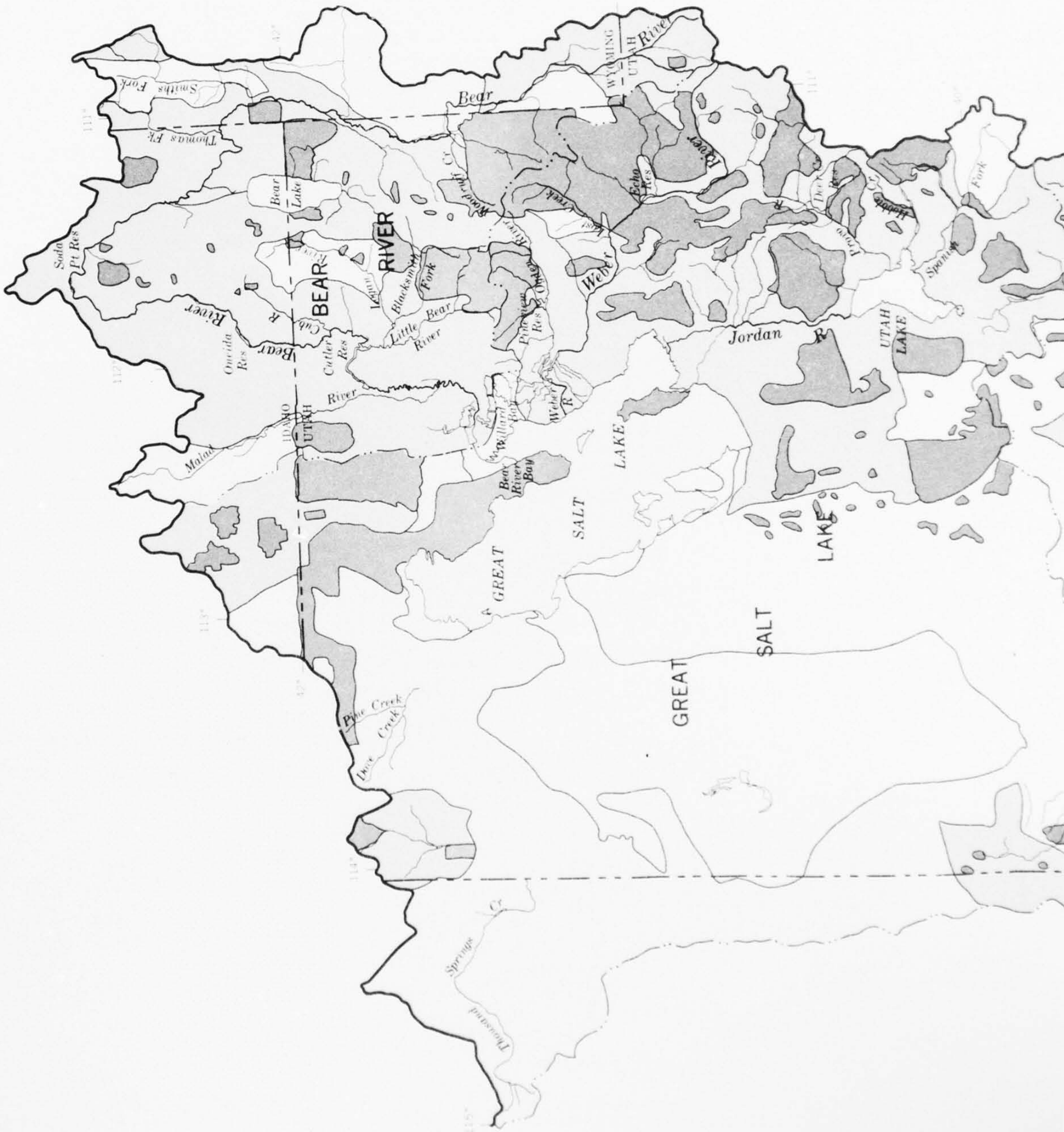


EXPLANATION

Existing treated areas
Includes intensive management related with treatment

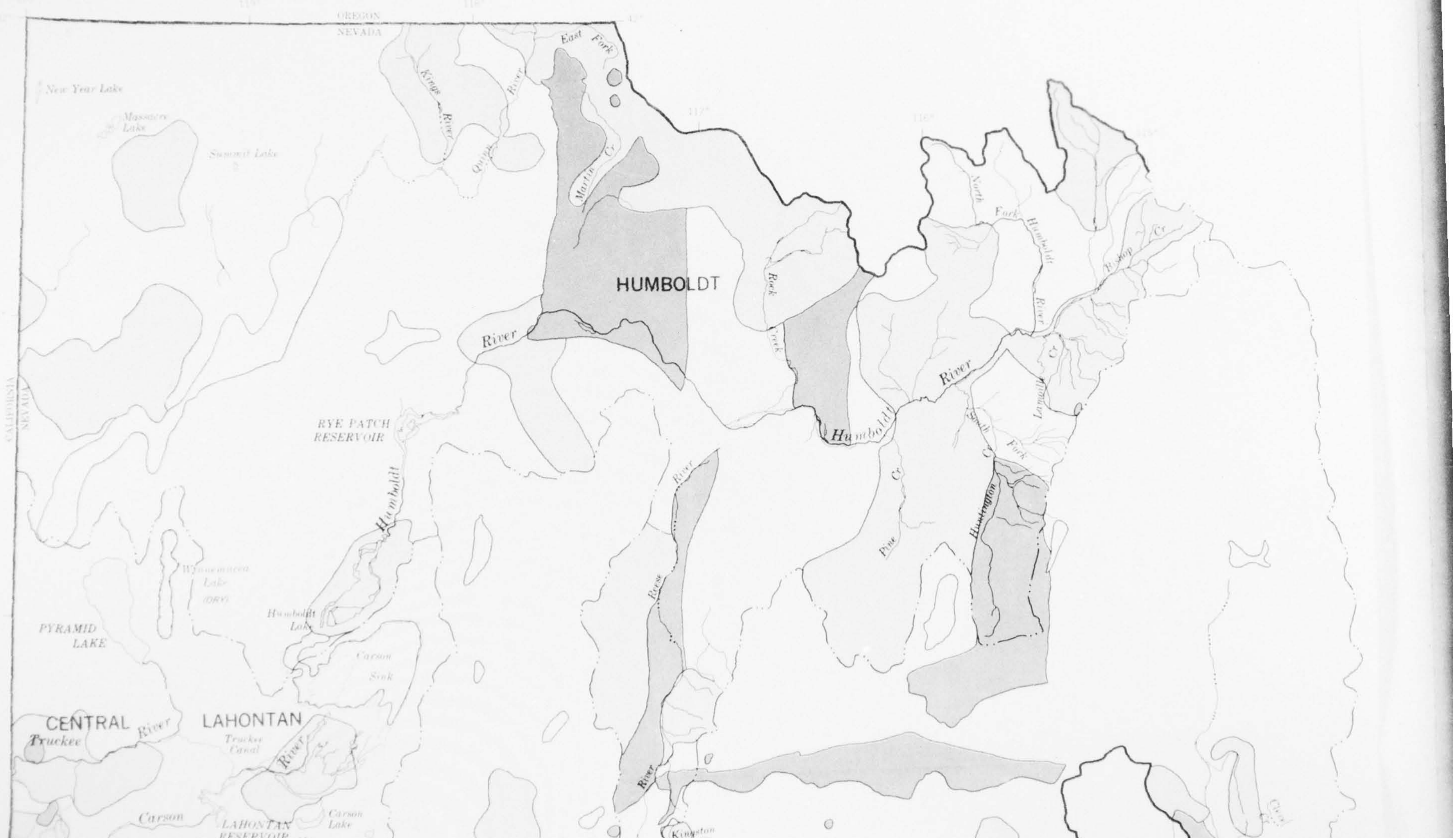
Potential watershed treatment areas
Includes intensive management related with treatment

Potential watershed treatment areas
Areas where physical treatment is generally inappropriate but will respond through intensive management

Barren and salt flats

Larger lakes

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK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NEVADA
CALIFORNIA
NEVADA
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
New Year Lake
Massacre Lake
Summit Lake
Kings River
Quinn River
East Fork
Martin Cr
River
Rock Creek
Humboldt
North Fork Humboldt River
Bishop Cr
Lamoille Cr
South Fork
Huntington Cr
Pine Cr
Reese River
Kingston Cr
RYE PATCH RESERVOIR
Humboldt Lake
Winnemucca Lake (DRY)
PYRAMID LAKE
Carson Sink
Truckee River
Truckee Canal
Carson River
Carson Lake
LAHONTAN RESERVOIR
LAKE TAHOE
Walker River
East Walker
Cleve Cr

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GREAT BASIN REGION COMPREHENSIVE FRAMEWORK STUDY. APPENDIX XVII--ETC(U)
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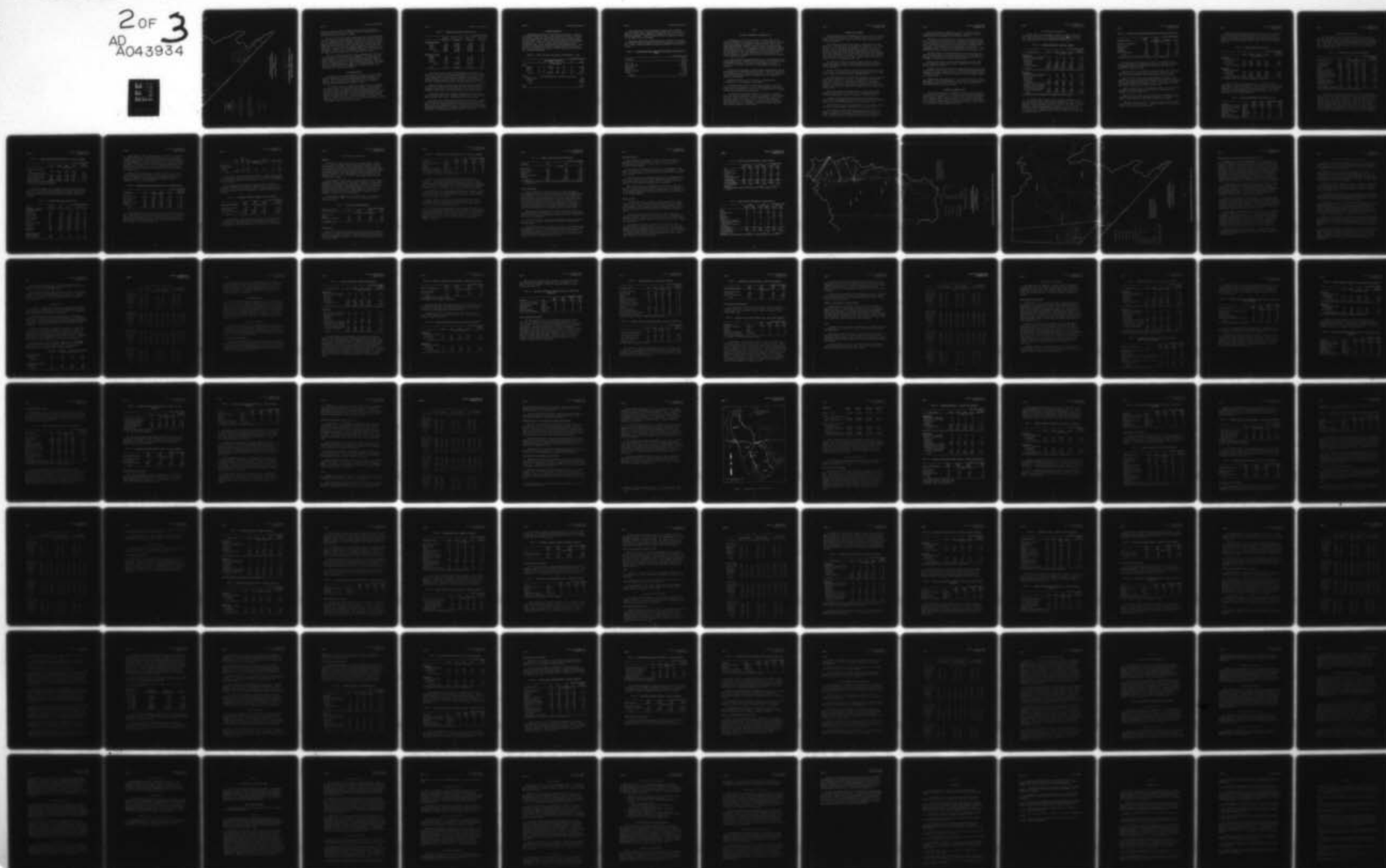

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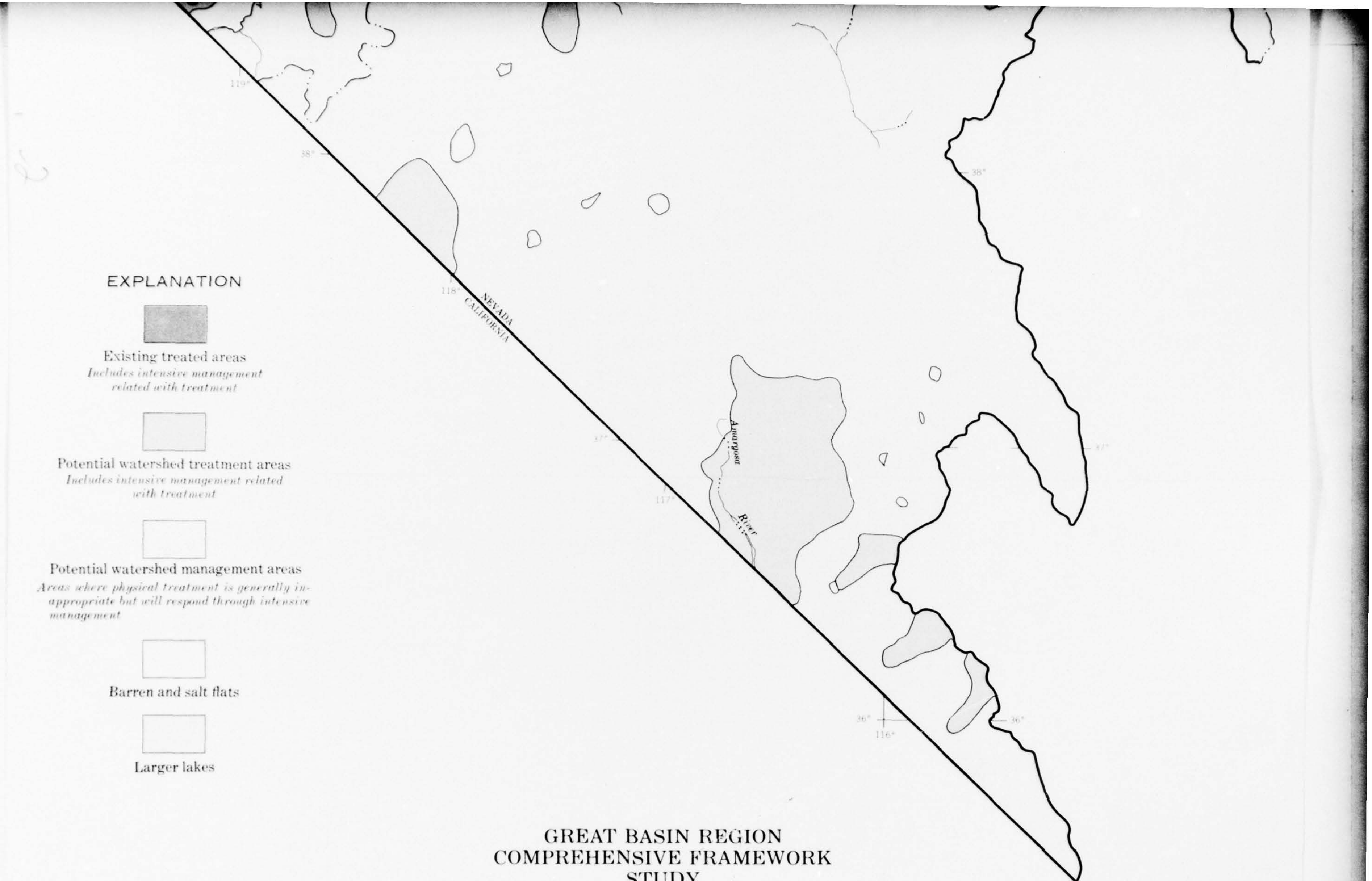
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963



GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(WESTERN SUBREGIONS)

0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

WATERSHED TREATMENT AND MANAGEMENT AREAS

These ores contain copper, molybdenum, and some associated metals, principally gold and silver, in various ratios of concentration, but the principal metal generally is copper.

Some of the 15 million tons of known reserves of beryllium-bearing material contain substantial amounts of lithium which might be recoverable as a byproduct. There are about 5 billion tons of iron ore in the Central Lahontan Subregion, of which 25 percent is a predicted resource. Huge barite resources are located in Nevada, most of which constitute a known reserve of 50 million tons, with an additional 50 million tons predicted. Diatomite occurs as widespread beds in the western part of the Region. There are no data available on tonnage, quality and extent, but these deposits probably entail a multimillion ton resource.

There are 2 billion long tons of known phosphate rock resources of which 90 percent is in the Bear River Subregion. The Great Salt Lake contains large resources of saline materials with estimated equally large resources in the brines of the saturated sediments. Known resources of sand and gravel are widely distributed throughout the Region and are considered adequate to supply all foreseeable needs. There are many other known and predicted deposits of various materials which contribute to the wealth of the Region.

Fish and Wildlife

Fishing waters are largely limited to areas in or near the major mountain ranges that form the eastern and western boundaries of the Region. In 1965 fishable waters consisted of about 4,200 miles of streams, and 0.5 million acres in natural lakes and impoundments. Table 29 shows fishable waters available in 1965.

The cutthroat trout was originally the principal native gamefish and is still one of the most sought after species. However, much of the present fishery is based on introduced species and the rainbow trout has replaced the cutthroat as the most widespread gamefish. The fishery for rainbow and other trout is maintained by extensive stocking with hatchery-reared fish. Natural spawning habitat is limited. Waters at lower elevations are generally suitable for warmwater fish including catfish, walleye, and bass. The mountain whitefish are found in the upper reaches of many major streams.

TABLE 29. INVENTORY OF FISHABLE WATERS - 1965

Great Basin Region

	Streams	Natural lakes	Reservoirs	Farm ponds
	(miles)	(acres)	(acres)	(acres)
Coldwater fishery				
Idaho	200	33,000	4,300	100
Nevada	1,200	262,000	16,300	300
Utah	2,000	40,500	26,600	1,400
Wyoming	300	500	2,000	100
Total	3,700	336,000	43,200	1,900
Warmwater fishery				
Idaho	0	0	0	10
Nevada	300	11,990	10,300	70
Utah	200	10	130,500	20
Wyoming	0	0	0	0
Total	500	12,000	140,800	100
Total	4,200	348,000	184,000	2,000

The present overall supply of fishing waters and facilities is adequate to make some sort of fishing available to essentially everyone. However, many of the better fishing waters are located considerable distances from major population centers. Preponderance of the available fishing opportunity occurs in large lakes and reservoirs where the full potential can only be realized through the use of boats.

Extensive areas of national forest and public domain make much of the potential opportunity for hunting, and other wildlife oriented recreation, accessible to the general public. Major concentrations of wildlife resources are found in or near the major mountain ranges.

Major game species of the Region include mule deer, elk, waterfowl, and upland game birds. Important nongame water birds including white pelicans, ibis, gulls, and others frequent the wetlands.

The major areas suitable and available for development of managed waterfowl habitat are located along the eastern shore of Great Salt Lake in Utah, the Humboldt-Carson sink in west central Nevada, and the Ruby Lake area in northeastern Nevada. Increased intensity of management would be necessary to offset habitat losses that would result from conversion of existing natural habitat lands to other uses.

Outdoor Recreation

Approximately 80 percent of the land in the Region is suitable for recreation purposes, most of which is publicly owned. There are large areas of open space and scenic beauty that can provide outdoor recreation experiences. Many of these areas have remained unused by recreationists. This lack of use may be attributed to the remoteness and difficulty of access. However, there are nationally known attractions, such as Lake Tahoe and Bryce Canyon National Park. Table 30 shows the availability of public lands by recreation land class. Most are in recreation land class III with 60 percent situated in the least populated subregions.

TABLE 30. LANDS AVAILABLE AND SUITABLE FOR RECREATION - 1965

Great Basin Region

	Recreation land class						
	I	II	III	IV	V	VI	Total
	(1,000 acres)						
Public							
Federal	0	45	58,038	218	495	20	58,816
State	0	4	177	0	0	0	182
Local	2	4	1	8	0	0	15
Total	2	53	58,216	226	495	20	59,013
Private	(Not inventoried by recreation land class)						
Indian Trust							940
Private							7,506
Total							8,446
Total							67,459

The availability of the recreational resource was considered under the concept that if specific opportunities were not provided, the demand by people would be modified to accept the types of recreation that were available. Under this concept there are adequate resources in this Region to meet the demand.

Satisfying water-based recreation demand is limited by population distribution relative to resource location, accessibility, and development. Table 31 shows the water surface area available for recreation in 1965.

TABLE 31. WATER SURFACE AREA AVAILABLE AND SUITABLE FOR RECREATION - 1965

Great Basin Region

Subregion	Supply
	(acres)
Bear River	94,394
Great Salt Lake	1,157,922
Sevier Lake	11,764
Humboldt	7,500
Central Lahontan	202,360
Tonopah	580
Region	1,474,520

PART V

REGIONAL COMPREHENSIVE FRAMEWORK PLAN

The purpose of this plan is to provide a broad guide for the orderly development of the Region's water, land, and related resources, to meet the projected requirements to the year 2020. Each of the supporting appendixes primarily outlines resource availability and single-purpose needs. Planning reports and data of State and Federal agencies were also used. The appendixes do not collectively present a fully integrated plan of development, but provide the major basis for the regional plan. Joint and conflicting uses resulting from an overall analysis of the needs and plans were resolved, where possible, in the formulation process.

In plan formulation authorized projects of the various State and Federal agencies were considered as were projects in the planning stage. The remaining portions of the plan are based essentially upon utilization of available resources and the judgment of experienced planners.

The plan was formulated to minimize adverse environmental impacts and compensate for unavoidable adverse effects. Conflicts and adverse effects which were not resolved are identified. This early identification should permit future analysis and resolution of conflicts in advance of development.

Generalized cost data for the plan are included without consideration to cost-repayment relationships.

The plan outlines one way in which projected needs can be met. There are alternative plans to meet the needs; however, time did not permit their consideration. Some of these alternatives are considered in State water plans now being prepared.

The general planning policy adopted for the Pacific Southwest study area outlined alternative levels of development. These include that level which would result using the OBE-ERS projections as the principal control, one or more levels of logical and potentially feasible capability to contribute to the national future needs, and that potential level of development limited by available land and other physical resources, except water.

Regional Plan Summary

The plan assesses the development and use of the resources indicated by the OBE-ERS projections. Environmental impacts are evaluated in general terms. The major elements of the plan are discussed in the following paragraphs.

Water depletions would increase about 1.5 MAF annually by 2020, about half of which would be for municipal and industrial uses. About 80 percent of the additional requirements for water occurs in the eastern subregions and would be developed principally from surface supplies and from authorized imports. Additional water development in the western subregions would be principally from ground-water supplies. Ground-water development would draw on storage in some areas which are remote from major sources of recharge. Water needed to maintain the terminal lakes is not included in the plan.

An additional 3.3 MAF of reservoir storage capacity would be developed by 2020. Storage for about 76,000 acre-feet was developed between 1965 and 1970. Most of the additional storage is in the eastern subregions.

Overall irrigation efficiency would increase approximately 5 percent by 2020. The planned efficiency would decrease diversions needed to meet projected depletions by about 800,000 acre-feet.

The limiting factor in selecting the 245,000 acres of new land for irrigation is availability of water. Of this amount, 239,000 acres would replace land lost to other uses, primarily for urban and industrial expansion. To meet additional production requirements, irrigation of 6,000 acres of new land, and 59,000 acres of idle land is planned. Crop yields are expected to increase 40 to 140 percent over present levels.

The various changes in land use to meet the plan reduce land available for grazing by 2.4 million acres. Forage production on remaining rangeland is planned to increase by 1.8 million AUMs.

Available timber producing land will decrease 135,000 acres by 2020. Intensive management and better harvest utilization will increase production of wood and wood products by 21 million cubic feet.

About 39 million acres of watershed land will be treated by 2020. Intensive treatment measures are planned on 11.5 million acres.

Principal metals expected to be produced by 2020, in order of value, are copper, iron ore, gold, and molybdenum. Important nonmetallic commodities include sand and gravel, cement, diatomite, and stone. Mineral production is expected to nearly double by 2020.

The plan contains a combination of two flood control concepts, floodwater control and flood plain management. The plan will reduce average annual flood damages by $16.5 million annually.

Recreation use is estimated to be 270 million recreation-days by 2020. The water and land resources of the Region are capable of meeting these demands. The large projected water-based recreation demand in the Tonopah Subregion can be met by substituting land-based types of recreation. Under existing legal, institutional, and financial arrangements, about 45 percent of the planned use would be met. Urban oriented recreation accounts for the majority of the recreation cost.

The water needs for fish and wildlife will be met by the plan. Limited big game habitat will curtail hunter success in the Bear River Subregion. The Region's large deer herds would be managed under more stringent controls and their winter range improved.

Electric power needs, exceeding 160,000 gigawatt-hours by 2020, will be supplied by fossil-fueled plants, hydroelectric facilities, nuclear plants, and imports.

Treatment of all municipal and most industrial effluents is planned to maintain or improve water quality. Planned watershed management and treatment will reduce sediment pollution of streams and lakes. Control of potential sources of pollution is essential if environmental quality is to be protected.

Planned water development costs to the year 2020 are $2.7 billion. OM&R costs are $140 million annually. Total costs, including associated development, would exceed $9 billion and total OM&R costs would be $555 million annually by the year 2020.

Elements of Regional Plan

The Great Basin Region is predominantly an agricultural area and will remain so through 2020. It contains important urban and industrial centers along the Wasatch Front in Utah, and in the Reno-Carson-Tahoe area in Nevada. These areas are projected to grow significantly and will create the largest demand for additional resources. The Region is one of the major mineral producing areas in the nation and will continue so, particularly in the production of copper.

Water Resources Development

Planned water uses, summarized in Table 32, indicate water withdrawals will increase about 2.3 MAF and depletions about 1.5 MAF by 2020. About 60 percent of the additional withdrawals and 46 percent of the depletions will be for municipal and industrial uses.

TABLE 32. PLANNED WATER USES - REGIONAL SUMMARY

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Withdrawals					
Municipal and industrial 1/	493	721	1,172	1,872	+1,379
Thermal electric power	7	13	43	124	+ 117
Recreation	8	13	20	32	+ 24
Minerals 1/	96	170	200	243	+ 147
Irrigation	7,032	7,109	7,292	7,483	+ 451
Fish and wildlife	1,017	1,068	1,117	1,214	+ 197
Total	8,653	9,094	9,844	10,968	+2,315
Depletions					
Municipal and industrial 1/	161	250	469	871	+ 710
Thermal electric power	7	13	43	124	+ 117
Recreation	6	7	9	15	+ 9
Minerals 1/	23	49	62	85	+ 62
Irrigation	2,933	3,030	3,235	3,455	+ 522
Nonirrigated wet meadows	1,120	1,082	980	910	- 210
Managed fish and wildlife	734	836	939	1,099	+ 365
Unmanaged fish & wildlife and associated wetland	405	364	364	309	- 96
Reservoir evaporation	624	600	648	678	+ 54
Total	6,013	6,231	6,749	7,546	+1,533

1/ Projected values adjusted in framework plan formulation.

The increased water use will require improved management of the existing limited supply. Improved water management includes increased efficiency of use, salvage, conversion, treatment, and reuse. Presently developed supplies and imports will be utilized in the Great Salt Lake Subregion. Increased development is planned on the principal and secondary streams. Additional ground-water development will occur in all subregions. The general sources of water supply for principal uses are shown in Table 33.

TABLE 33. SOURCES OF ADDITIONAL DIVERSIONS FOR PRINCIPAL USES BY 2020

Great Basin Region

Principal use	Stream-flow	Ground water	Imports	Total
		(1,000 acre-feet)		
Municipal & industrial	793	355	231 1/	1,379
Electric power	65	52	0	117
Recreation	8	16	0	24
Minerals	62	84	0	146
Irrigation	275	111	66	451
Fish and wildlife	156	41	0	197
Total	1,359	659	296	2,314

1/ Based on import alternative in Great Salt Lake Subregion.

The additional water supply in the Bear River Subregion will be obtained principally from regulation of surface streamflow, conversion of unmanaged wetlands to managed fish and wildlife use, and some augmentation from ground water.

Additional water in the Great Salt Lake Subregion will be obtained from both surface and ground water, and imports. Extensive reuse of return flows from municipal and industrial diversions is planned.

Additional water in the Sevier Lake Subregion, principally for agriculture, will be obtained from development of ground-water supplies, imports, and additional regulation of surface streamflows. The development program includes direct salvage of water from wetlands by pumping and drainage, mainly along the Sevier River system.

Additional water supply in the Humboldt Subregion will be obtained principally from ground-water supplies and to a limited extent by regulation of surface streamflow.

Additional water supply in the Central Lahontan Subregion will be obtained from ground water, additional regulation of streamflows, and reuse of water diverted for municipal and industrial purposes.

Additional water supply in the Tonopah Subregion will be obtained almost entirely from ground water. Streams are small, widely scattered, and do not justify extensive development.

Additional water needed on present irrigated land can be supplied by more efficient use of present diversions. A planned 5 percent increase in overall efficiency can meet this need and about half the needs for new cropland. The additional water supply for new cropland would require new development. Table 34 shows the planned irrigation water use.

TABLE 34. PLANNED IRRIGATION WATER USE

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Diversions					
Presently developed cropland1/	7,032	6,927	6,857	6,618	- 414
New cropland	0	182	435	865	+ 865
Total diversions	7,032	7,109	7,292	7,483	+ 451
Depletions					
Presently developed cropland1/	2,933	2,948	3,039	3,066	+ 133
New cropland	0	82	196	389	+ 389
Total depletions	2,933	3,030	3,235	3,455	+ 522

1/ Includes water for idle land returned to production.

Table 35 shows the facilities required to develop the plan. Development of reservoir storage will be principally for irrigation and flood control except in the Great Salt Lake Subregion where the greatest demands will be for municipal and industrial purposes. About 76,000 acre-feet of storage capacity has been developed from 1965 to 1970, principally in the eastern subregions.

TABLE 35. FACILITIES REQUIRED TO DEVELOP THE PLAN

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	1,600	981	700	3,281
Conveyance facilities	miles	226	146	245	617
Pumping plants	number	4	3	9	16
Irrigation laterals	1000 acres	43	29	31	103
Drainage	1000 acres	66	86	74	226
Water treatment	1000 AF.	113	224	278	615
Waste water treatment	1000 AF.	142	237	306	685

Land Resources Development

Land use changes planned for the 1965-2020 period are shown in Table 36. The greatest land use increases occur for recreation, and fish and wildlife. These uses, however, accommodate other simultaneous uses. The greatest impacts occur when expanding urban and industrial centers encroach on land developed for other uses, principally irrigation. Grazing land use will decrease by 2.4 million acres because of the increase in other uses.

TABLE 36. PLANNED LAND USE - REGIONAL SUMMARY

Great Basin Region

Principal use[1]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	2,114	2,104	2,098	2,120	+ 6
Dry cropland	1,083	1,074	1,082	1,152	+ 69
Grazing land	63,238	62,481	61,757	60,820	-2,418
Timber	2,352	2,257	2,237	2,217	- 135
Urban and industrial	365	434	533	661	+ 296
Outdoor recreation	430	896	1,413	1,928	+1,498
Wilderness and scenic	129	950	950	950	+ 821
Flood control measures	32	67	128	160	+ 128
Military and related	4,962	4,962	4,962	4,962	0
Minerals	421	856	1,044	1,270	+ 849
Fish and wildlife	2,056	3,362	3,667	3,989	+1,933
Classified watershed	352	427	510	608	+ 256
Transportation and utilities	611	706	770	811	+ 200
Water control reservoirs	320	321	362	379	+ 59

1/ Multiple uses of land are made in most categories.

Production on an additional 304,000 acres of land is planned by 2020. This includes developing 245,000 acres of new land, and restoring 59,000 acres of idle land to production. About 239,000 acres of land will be lost to other uses, principally in the Great Salt Lake and Central Lahontan Subregions; therefore, total productive land will increase 65,000 acres by 2020 as shown in Table 37. Some shifts were made in allotted production from the Great Salt Lake and Central Lahontan Subregions to neighboring subregions. These shifts generally locate irrigation development in closer proximity to water supplies, and minimize future encroachment from urban and industrial expansion.

TABLE 37. PLANNED IRRIGATED LAND DEVELOPMENT - REGIONAL SUMMARY

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	2,114	2,114	2,104	2,098	-
Loss to other uses 1/	-	-65	-78	-96	-239
New land development 1/	-	55	72	118	+245
Net developed land	2,114	2,104	2,098	2,120	+ 6
Idle land remaining	116	122	79	57	+ 59 2/
Productive land	1,998	1,982	2,019	2,063	+ 65

1/ Values are incremental amounts.
2/ Idle land restored to production.

Agricultural production on irrigated land will increase about 50 to 140 percent by 2020. Table 38 shows the estimated cropland yields. These yields can be met with an adequate water supply, improved crop varieties, adequate fertilization, and improved agricultural water management.

TABLE 38. ESTIMATED IRRIGATED CROPLAND YIELDS

Great Basin Region

Crops	Unit per acre	1965	2020	Increase Yield	Increase Percent
Irrigated cropland					
Native hay	ton	1.2	1.9	0.7	53
Alfalfa hay	ton	3.2	5.4	2.2	69
Alfalfa seed	Cwt	1.8	2.6	0.8	44
Corn silage	ton	15.0	26.5	11.5	70
Corn for grain	bu	53.0	98.0	45.0	85
Feed grains	bu	50.0	96.0	46.0	92
Wheat	bu	35.0	79.0	44.0	116
Noncitrus fruits	bu	375.0	900.0	525.0	140
Vegetables	ton	5.0	12.0	7.0	140
Cotton	lbs	800.0	1,400.0	600.0	75
Sugar beets	ton	13.0	18.7	5.7	44
Potatoes	Cwt	184.0	358.0	174.0	95
Irrigated pasture					
Native pasture	AUMs	2.0	3.2	1.2	60
Improved pasture	AUMs	5.7	9.1	3.4	60

Land suitable for dry cropland farming is principally confined to the eastern subregions. Additional needs will be met by restoring 142,000 acres in conservation reserve to production and development of suitable rangeland. These two sources will meet requirements including the replacement of dry cropland converted to other uses, principally irrigation. Production will be increased through management practices. These include conserving soil moisture, maintaining soil fertility, controlling disease and insects, reducing erosion, and using improved crop varieties.

Rangeland forage production is planned to increase 1.8 million AUMs by 2020 as shown in Table 39. This is about 56 percent of the potential production on land available for grazing in 2020. This increased production will be accomplished by improved grazing management and land treatment measures.

TABLE 39. PLANNED RANGE FORAGE PRODUCTION FOR LIVESTOCK GRAZING

Great Basin Region

Subregions	1965	1980	2000	2020	Increase 1965-2020
		(1,000 AUMs)			
Bear River	535	597	685	762	+ 227
Great Salt Lake	907	1,023	1,187	1,292	+ 385
Sevier Lake	719	758	930	1,020	+ 301
Humboldt	1,002	1,007	1,395	1,636	+ 634
Central Lahontan	232	242	283	302	+ 70
Tonopah	704	697	838	919	+ 215
Total	4,099	4,324	5,318	5,931	+1,832

Timber production is expected to increase 21 million cubic feet by 2020. This is about 41 percent of the potential increase in production but is considered reasonable as the demand for other uses of forest land increases. The demands, beyond this expected increase in production, will continue to be met from imports. The planned treatment program by 2020 is shown in the following tabulation.

	Bear River	Great Salt Lake	Sevier Lake	Humboldt	Central Lahontan	Tonopah	Region
				(1,000 acres)			
Regeneration	67	15	104	-	2	2	190
Treating timber stands	41	35	433	1	6	3	519
Total	108	50	537	1	8	5	709

Regeneration includes planting and seeding. Treating timber stands includes pruning, thinning, and pest control. Treatment and management of noncommercial timber areas for harvest of posts, poles, and Christmas trees is planned.

The planned watershed treatment program is shown in Table 40. Irrigated cropland treatment includes improved water application and drainage. Dry cropland treatment includes erosion and sediment control while the program on forest and rangeland is primarily land treatment measures.

TABLE 40. WATERSHED TREATMENT PROGRAM - REGIONAL SUMMARY

				Great Basin Region
Land resource group	1965-1980	1980-2000	2000-2020	Total 1965-2020
		(1,000 acres)		
Irrigated cropland	348	468	437	1,253
Dry cropland	298	260	265	823
Forest and rangeland	11,720	15,675	9,670	37,065
Total	12,366	16,403	10,372	39,141

Land management offers the greatest potential for solving watershed problems. Proper management of grazing and crop production, coordinated with recreation use, mineral exploration and development, urban expansion, and other land uses is a necessary part of the plan.

Other Resources Development

Minerals

The principal metals expected to be produced by 2020, ranked in terms of value, are copper, iron ore, gold, and molybdenum. Copper should remain the dominant mineral through 2020. Several large iron ore deposits may become major sources of supply for the western states. Gold production in the Humboldt Subregion should continue through 2020. The expanding need for molybdenum should lead to development of the Region's deposits by 1980. The production of other metals will also increase, many of them as the result of processing complex ores for the recovery of copper.

Sand and gravel should become the second largest mineral commodity produced in 1980 and remain so beyond 2020. Production of many other nonmetallics, including cement, diatomite, and stone, will increase principally in response to national demands. Sources of saline brines include Great Salt Lake and underground deposits. Production of saline minerals, including salt, sodium, magnesium, and potash will increase. Lithium production from brine in the Great Salt Lake Subregion is expected to grow through 2020.

The major fuel commodities, coal and petroleum, are expected to increase in output by 1980. Table 41 shows the expected value of mineral production.

TABLE 41. VALUE OF MINERAL PRODUCTION

Great Basin Region

Industrial sector	1965	1980	2000	2020
		(millions of dollars)1/		
Mineral fuels	1	5	5	5
Metals	272	359	385	403
Nonmetallic minerals	57	121	169	224
Total	330	485	559	632

1/ 1957-59 base.

Flood Control

The flood control plan consists of both structural and nonstructural measures. Structural measures include storage reservoirs, levees, channels, and watershed treatment. Nonstructural measures are primarily flood plain management techniques. Table 42 shows the elements of the flood control plan.

TABLE 42. ELEMENTS OF THE FLOOD CONTROL PLAN - REGIONAL SUMMARY

				Great Basin Region	
Element	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	578	580	186	1,344
Levees	miles	20	36	42	98
Channels	miles	103	74	36	213
Watershed treatment1/	1000 acres	228	249	246	723
Flood plain management	No. areas	6	15	13	34

1/ Included in watershed treatment program.

Reservoir storage is provided principally in multiple-use structures. Levee and channel improvements are planned for critical locations. Land treatment measures and management practices include contour trenches, gully plugs, small retention reservoirs, revegetation, and controlled use of watershed areas. These will preserve or restore watershed areas to a condition that reduces flood peaks and erosion.

Nonstructural flood plain management measures are planned to reduce flood damage, principally in downstream flood plains. These include flood plain zoning, tax adjustments, flood insurance, local development policies, and flood forecasting.

Table 42 does not include five multiple-purpose reservoirs in California. These structures, with a combined flood control capacity of 140,000 acre-feet, will provide protection for the major urban centers in the Central Lahontan Subregion.

Table 43 shows the average annual flood damages prevented by the plan. It is not possible to prevent all flood damages. Average annual flood damages remaining in 2020 with the flood control plan in operation are about $7.8 million. These remaining damages will occur mainly in downstream areas because of increased development in the flood plains. Damages in upstream areas will decrease because of planned land treatment measures.

TABLE 43. AVERAGE ANNUAL FLOOD DAMAGE PREVENTED

Great Basin Region

Subregion	1980	2000	2020
	($1,000)		
Bear River	140	481	979
Great Salt Lake	1,200	3,515	7,629
Sevier Lake	325	769	1,380
Humboldt	216	732	1,504
Central Lahontan 1/	696	2,135	4,054
Tonopah	145	467	924
Region	2,722	8,099	16,470

1/ A substantial portion of these values are derived from 5 reservoirs in California.

Outdoor Recreation

Planned increase in recreation use will be about 270 million recreation-days by 2020, requiring acquisition of about 93,000 acres of land, primarily for Class I and II uses. The plan was developed under the concept that if recreation opportunities were not provided, the demand by people would be modified to accept those that were available, even though the quality may be reduced. Under this concept, the resources of the Region are adequate to meet projected demands except for water-based recreation in the Tonopah Subregion. This demand originates principally from population centers outside the Region and can be met by substitution of land-based recreation opportunities.

Under present constraints, about 118 million recreation-days can be developed by 2020. Developments to meet the additional unrestricted demand of 152 million recreation-days requires new legal, institutional, and financial arrangements.

If unlimited supplies of water and land-based recreation areas and facilities were available, the demand by 2020 would be 398 million recreation-days.

To insure preservation of natural resources for future generations, approximately 14 rivers and streams have been identified as wild, scenic, or recreational rivers. Twenty-one areas have been identified for consideration as additions to the wilderness system. Areas with unique natural attributes and cultural value have been identified and should be given protection through legislative action.

Fish and Wildlife

Better management practices for fish and wildlife purposes are essential and will be implemented. Suitable wildlife habitat is limited and full utilization of these areas is essential to meet increased hunting demands.

Development plans include fisheries in new impoundments, access roads, fish hatcheries, and habitat improvement and management. Streamflows of suitable quantity and quality will be maintained for fisheries where possible.

Sport hunting programs include land acquisition and development, access road construction, and habitat improvement and management. Most of the additional 1.9 million acres of land use planned for fish and wildlife is associated with big game habitat management.

Additional development of 226,000 acres for waterfowl habitat is planned. Included are areas around the eastern shore of Great Salt Lake in the Bear River and Great Salt Lake Subregions, the Humboldt Sink in the Humboldt Subregion, and Franklin Lake area in the northern part of the Tonopah Subregion.

Electric Power

Electric power will be supplied by fossil-fueled plants, hydroelectric facilities, continued imports, and in the final time frame, nuclear plants. Tables 44 and 45 show the planned staging of electric power resources for the eastern and western subregions, respectively. The maps following page 70 show the electrical facilities planned by 2020.

Land areas meeting siting requirements of fossil-fueled and nuclear plants are available within close proximity to adequate water supplies. Adequate pollution control facilities for coal-fired plants will be required to permit location in close proximity to water supplies and load centers.

Conventional hydroelectric plants will be limited to those developed under the Central Utah Project in the Great Salt Lake Subregion. Pumped storage hydroelectric facilities will utilize storage developed for other purposes as the lower reservoir. About 78,000 acre-feet of new storage would be required for upper reservoirs. Two sites are planned in the Great Salt Lake Subregion, and one each in Bear River and Central Lahontan Subregions.

TABLE 44. STAGING OF ELECTRIC POWER RESOURCES - EASTERN SUBREGIONS

Great Basin Region

	1980		2000		2020	
	Capacity (mw)	Energy (gwh)	Capacity (mw)	Energy (gwh)	Capacity (mw)	Energy (gwh)
Hydro	150	500	150	500	150	500
Central Utah Project	130	320	250	700	250	700
Gas turbine	0	0	600	1,000	0	0
Conventional steam	300	1,300	1,380	4,500	2,340	5,600
Nuclear	0	0	0	0	9,200	64,000
Pumped storage	560	320	1,860	1,000	4,000	2,000
Colorado River Storage Project imports	259	1,351	259	1,201	259	1,201
Imported steam	1,200	8,930	5,000	38,000	7,800	43,000
Total loads	2,599	12,721	9,499	46,901	23,999	117,001
Reserve requirements	449		1,539		4,049	
Total loads 1/	2,150	12,240	7,960	45,400	19,950	114,000
Pumped storage load		481		1,501		3,001
Load factor	67.5%		67.3%		66.9%	

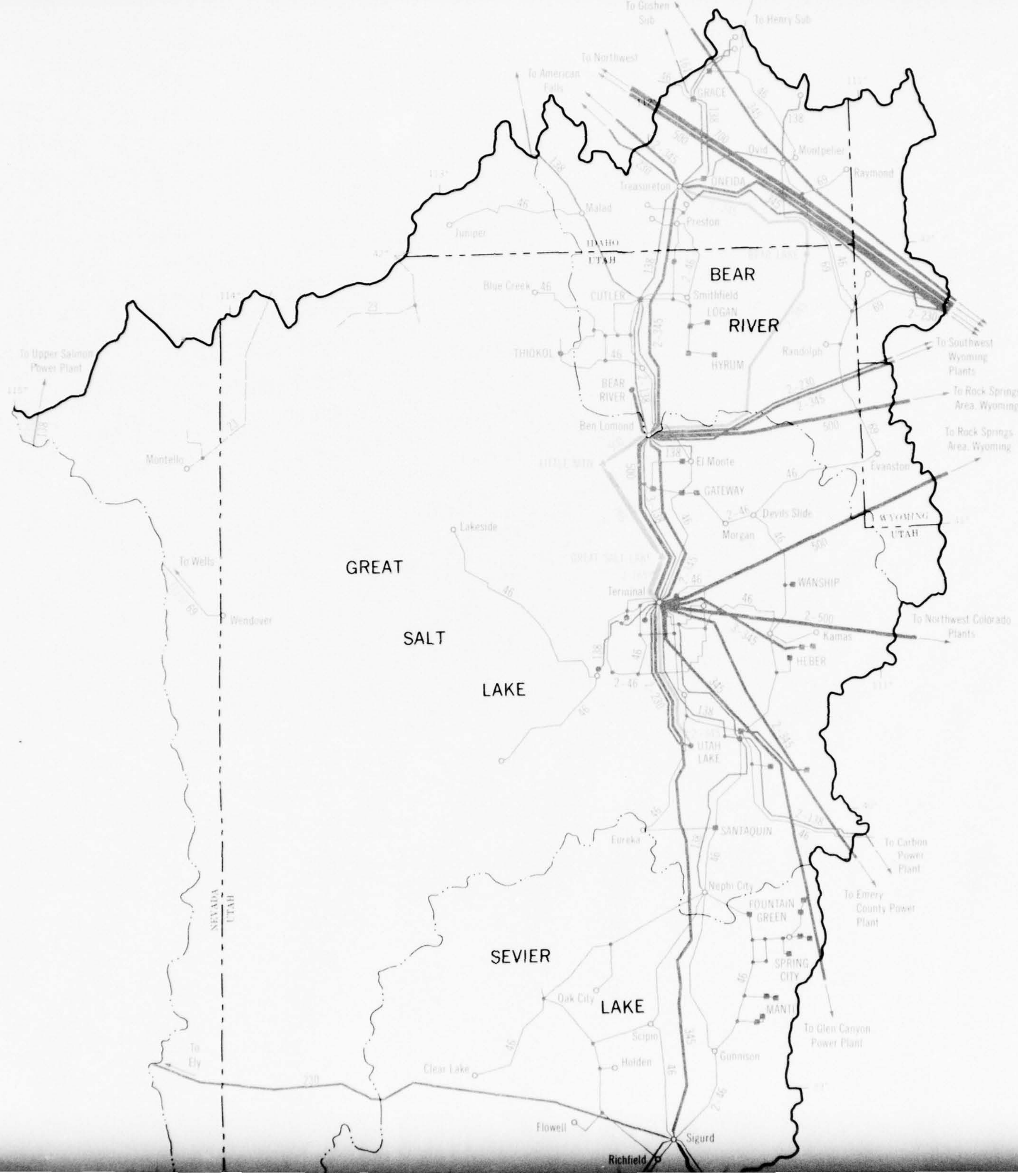
1/ Excludes industrial generation for industrial use. Pumped storage load is not included.

TABLE 45. STAGING OF ELECTRIC POWER RESOURCES - WESTERN SUBREGIONS

Great Basin Region

	1980		2000		2020	
	Capacity (mw)	Energy (gwh)	Capacity (mw)	Energy (gwh)	Capacity (mw)	Energy (gwh)
Hydro	9	50	9	50	0	0
Diesel	39	13	20	10	0	0
Conventional steam	704	3,415	2,302	14,951	2,502	6,711
Gas turbine	25	6	425	120	552	150
Nuclear	0	0	0	0	4,440	31,200
Geothermal	0	0	0	0	340	2,500
Pumped storage	0	0	600	400	1,200	850
BPA import						
Harney Electric Cooperative	12	52	35	150	110	500
Colorado River Commission imports						
Eureka-Ely area	31	119	31	119	31	119
Valley Electric Cooperative	10	50	50	220	145	600
Idaho import						
Elko-Wells area	10	55	32	180	100	570
Total load	840	3,760	3,504	16,200	9,420	43,200
Reserve requirements	140		584		1,570	
Total loads 1/	700	3,760	2,920	15,600	7,850	42,000
Pumped storage loads		0		600		1,200
Load factor	61.3%		63.3%		62.8%	

1/ Excludes industrial generation for industrial use. Pumped storage load is not included.



BEAR
RIVER
GREAT
SALT
LAKE
SEVIER
LAKE
To Goshen Sub
To Henry Sub
To Northwest
To American Falls
To Upper Salmon Power Plant
To Southwest Wyoming Plants
To Rock Springs Area, Wyoming
To Rock Springs Area, Wyoming
To Northwest Colorado Plants
To Carbon Power Plant
To Emery County Power Plant
To Glen Canyon Power Plant
To Wells
To Ely
IDAHO
UTAH
WYOMING
UTAH
NEVADA
UTAH
GRACE
Ovid
Montpelier
Raymond
Treasureton
ONEIDA
Malad
Juniper
Preston
Blue Creek
CUTLER
Smithfield
LOGAN
THIOKOL
HYRUM
Randolph
BEAR
RIVER
Ben Lomond
El Monte
GATEWAY
Devils Slide
Morgan
Evanston
Lakeside
Terminal
WANSHIP
Kamas
HEBER
Montello
Wendover
UTAH
LAKE
SANTAQUIN
Eureka
Nephi City
FOUNTAIN
GREEN
SPRING
CITY
Oak City
MANTI
Scipio
Gunnison
Holden
Clear Lake
Flowell
Sigurd
Richfield

NOTE: No attempt has been made to forecast additions or deletions of transmission facilities of less than 230 kv. Some lower voltage transmission lines and smaller generating plants in congested areas are omitted.

EXPLANATION

Nuclear power plant

Hydro power plant

Fuel power plant

Substation or city

Boundary of hydrologic subregions

Transmission lines:

- 700–765 KV
- 500 KV
- 345 KV
- 230 KV
- 138–161 KV
- 46–69 KV
- 13–34 KV
- Connecting lines
- Crossover lines

Note: Solid symbol installed by year 2000
Screened symbol installed by year 2020

GREAT BASIN REGION
COMPREHENSIVE FRAMEWORK
STUDY
(EASTERN SUBREGIONS)

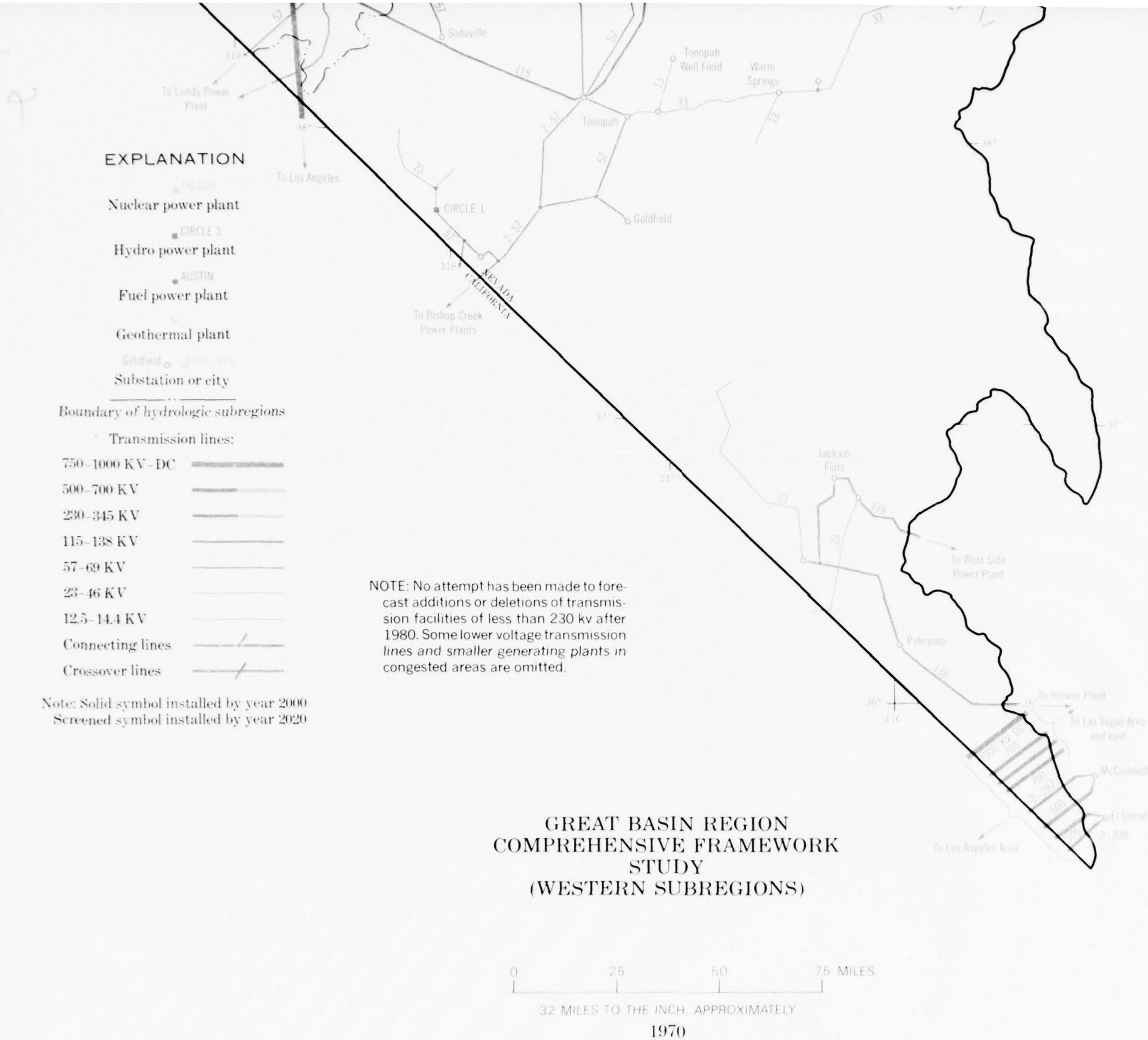
0 25 50 75 MILES

32 MILES TO THE INCH, APPROXIMATELY

1970

PRINCIPAL ELECTRIC FACILITIES 2000 AND 2020


OREGON
NEVADA
CALIFORNIA
NEVADA
To Northwest
To Northwest
To Upper Salmon Power Plant
To Wendover
To Sigurd
To Feather River Plants
To Truckee
To Meyers
HUMBOLDT
CENTRAL
LAHONTAN
TONOPAH
WINNEMUCCA
BATTLE MTN
ELKO
CARLIN
LAMOILLE
Adobe
Wells
Kings River
Paradise Valley
Gerlach
Empire
Imlay
Oreana
Rochester
Duval
Reese River
Cortez
Diamond Valley
Steptoe Valley
EUREKA
AUSTIN
Fallon
McGill
ELY
Ruth
TRACY
Valley Road
Warm Springs
VERDI
WASHOE
LAKE
Carson
Brunswick
Glenbrook
Stateline
Buckeye
Anaconda
Yerington
Smith Valley
Lahontan
Silver Springs
FORT CHURCHILL
Scheelite
Gabbs
BABBITT
Sodaville
Round Mtn.
Manhattan
Railroad Valley
Lockes
Tonopah Well Field
Warm Springs
250 DC



PRINCIPAL ELECTRIC FACILITIES 2000 AND 2020

Water Quality, Pollution Control, and Health Factors

Development of additional environmental control programs at all levels of government, and increased support of present programs, are planned to protect the public from air and water pollution. Increased emphasis is placed in the areas of public water supply and solid waste management. Domestic water supplies should be recognized as the highest priority use for existing high quality water. Improved solid waste management techniques, especially recycling and reclamation programs, are planned to cope with the burgeoning quantities of solid wastes. Increased monitoring and abatement efforts are planned to control radiological and air pollution sources. Additional coordination and implementation procedures are necessary to insure that vector control measures are included in water and related land resources developments.

The maintenance of an acceptable level of water quality is vital to the economy, environment, and general well-being of people. The Federal Water Quality Act of 1965 requires the states to establish water quality standards for interstate streams within their boundaries. The implementation of plans to meet these standards would control pollution in these streams. Water quality control programs are also planned for the major river systems within the Region.

Construction of additional municipal water treatment plants and expansion of existing plants will be necessary to meet drinking water standards. All domestic water systems should employ means to safeguard the public against waterborne diseases. The planned methods of treating return flows to reduce water pollution include secondary and tertiary treatment, changes in manufacturing process, in-stream aeration, flow augmentation from reservoirs, and land use controls.

Most municipal and industrial return flow will receive secondary treatment by 2020. In major urban centers, this level of treatment is not adequate to protect water quality. Advanced treatment to remove nutrients from municipal return flows is planned for the Reno-Sparks area, the Lake Tahoe Basin, and the Carson City area. Export of all effluents and solid wastes from the Lake Tahoe Basin is planned. Pollution control measures planned for the Jordan and Weber Rivers and Great Salt Lake include centralization of waste treatment facilities and advanced treatment to permit reuse of return flows.

Thermal pollution from the discharge of cooling waters will be avoided by using heat dissipation methods at the source. Emergency procedures for handling accidental discharges of hazardous materials will be improved.

Effects of Development to Meet the Plan

Available surface and ground-water supply that can be reasonably developed will be utilized to meet the plan. Mining of ground water may be necessary in localized areas. Required storage and regulation of streamflow will change flow regimen.

The major effect of the plan is an increase of 1.5 MAF of depletions from the water supply. The greatest change in use is the conversion of irrigation water to municipal and industrial use. Some curtailment of use will be required, such as municipal depletions in the Reno-Sparks area. Higher irrigation efficiencies and direct salvage will reduce water supplies to wetlands.

Inflows to terminal lakes will continue to reduce and lake levels will continue to decline. Additional sources of supply or curtailment of upstream uses, would be required to maintain Pyramid and Walker Lakes. Management, including diking, would be necessary to maintain parts of Great Salt Lake.

By 2020, most of the reasonably available water will be utilized. Continued growth beyond 2020 will require additional imports, mining of ground water, or desalting of brackish waters. This will also be true if growth exceeds the planned development before 2020.

Development of the plan will cause significant changes in land use and increased intensity of use. Conversion of irrigated cropland to urban and industrial use will require development of new land more remote from available water supplies. At present this is creating large contiguous urban areas without open space, and requiring conveyance of water longer distances to new irrigated cropland. Proper land use planning, including zoning, will minimize adverse effects.

Large areas presently used for grazing and occasional hunting will be used more for recreational purposes. Watershed protection and management problems will increase as these areas are more intensively used. Additional areas will be required for exclusive uses, such as classified watershed. This will shift existing uses to remaining multiple-use lands.

Flood plain management in urban areas will reduce flood damages and provide open space for recreation and esthetics. Generation of solid waste is expected to exceed two million tons annually by 1980. The effects of disposing of these large quantities of materials are only partially assessed. Measures, including recycling, need to be implemented to reduce the volume and to minimize the effect on the environment.

Increased mining activity will scar large areas and increase erosion and sedimentation problems. Planned restoration practices will minimize the effects of these developments.

Planned thermal electric power plants will utilize closed cooling systems. This will prevent thermal pollution of streams. Development of improved precipitators will control air pollution. The planned location of transmission lines will minimize the esthetic effects on the environment.

Regional Costs

A summary of estimated costs for the plan is presented in Table 46. Costs are shown for eight major functions and remaining functions are grouped under "other development." Costs are further divided between "water development" and "associated development."

Water development costs are for developing the water supply, conveying it to the point of use, initial treatment, and retreatment of return flows. Watershed treatment and flood control measures required to protect or improve the water supply and prevent damage from flooding are included. Costs associated directly with use generally are not included.

Associated development costs are for facilities to utilize the developed water supply, land treatment, and programs to manage, maintain, or improve production of the land. These include the cost of thermal-electric generating facilities and transmission lines, and land acquisition and development for land-based recreation. Associated costs also include non-Federal recreation costs that cannot be met under present legal, institutional, and financial constraints.

Installation costs are for initial construction or development. Operation, maintenance, and replacement (OM&R) costs are the annual funds required at the end of each time frame. Average annual installation costs are shown in the following tabulation.

	1965-1980	1980-2000	2000-2020	1965-2020
		(millions of dollars)		
Water development				
Federal	32	23	15	23
Non-Federal	22	26	32	27
Total	54	49	47	50
Associated development				
Federal	12	12	14	13
Non-Federal	25	58	206	103
Total	37	70	220	116

TABLE 46. COMPREHENSIVE FRAMEWORK PLAN COSTS - REGIONAL SUMMARY

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal- lation	OM&R Incr.	OM&R Cum.	Instal- lation	OM&R Incr.	OM&R Cum.	Instal- lation	OM&R Incr.	OM&R Cum.
				(Thousands of 1965 constant dollars)					
1965-1980 Time frame									
Municipal & industrial	122,100	4,290		0	0		122,100	4,290	
Irrigation & drainage	139,300	4,020		99,900	5,620		239,200	9,640	
Electric power	229,200	4,980		141,400	11,240		370,600	16,220	
Flood control	83,500	1,020		0	0		83,500	1,020	
Outdoor recreation	44,300	950		208,600	22,610		252,900	23,560	
Fish and wildlife	19,000	120		27,800	2,080		46,800	2,200	
Water quality	123,500	13,140		0	0		123,500	13,140	
Land management	25,900	1,500		81,400	4,590		107,300	6,090	
Other development	19,200	3,810		0	0		19,200	3,810	
Total program	806,000	33,830		559,100	46,140		1,365,100	79,970	
Federal	483,300	6,460		180,500	9,240		663,800	15,700	
Non-Federal	322,700	27,370		378,600	36,900		701,300	64,270	
1980-2000 Time frame									
Municipal & industrial	99,400	5,200	9,490	0	0	0	99,400	5,200	9,490
Irrigation & drainage	146,100	1,260	5,280	137,300	7,560	13,180	283,400	8,820	18,460
Electric power	463,800	10,720	15,700	834,400	76,000	87,240	1,298,200	86,720	102,940
Flood control	149,100	1,420	2,440	0	0	0	149,100	1,420	2,440
Outdoor recreation	26,000	180	1,130	319,900	32,490	55,100	345,900	32,670	56,230
Fish and wildlife	5,700	40	160	27,800	2,080	4,160	33,500	2,120	4,320
Water quality	60,500	21,490	34,630	0	0	0	60,500	21,490	34,630
Land management	27,800	960	2,460	87,700	2,900	7,490	115,500	3,860	9,950
Other development	3,500	3,510	7,320	0	0	0	3,500	3,510	7,320
Total program	981,900	44,780	78,610	1,407,100	121,030	167,170	2,389,000	165,810	245,780
Federal	465,500	7,720	14,180	246,200	11,230	20,470	711,700	18,950	34,650
Non-Federal	516,400	37,060	64,430	1,160,900	109,800	146,700	1,677,300	146,860	211,130
2000-2020 Time frame									
Municipal & industrial	181,900	10,660	20,150	0	0	0	181,900	10,660	20,150
Irrigation & drainage	153,800	2,980	8,260	132,300	7,470	20,650	286,100	10,450	28,910
Electric power	425,700	9,070	24,770	3,682,600	185,020	272,260	4,108,300	194,090	297,030
Flood control	54,200	960	3,400	0	0	0	54,200	960	3,400
Outdoor recreation	13,200	30	1,160	483,400	48,810	103,910	496,600	48,840	105,070
Fish and wildlife	2,500	40	200	44,500	3,350	7,510	47,000	3,390	7,710
Water quality	79,200	33,710	68,340	0	0	0	79,200	33,710	68,340
Land management	18,000	840	3,300	58,200	2,560	10,050	76,200	3,400	13,350
Other development	4,000	3,560	10,880	0	0	0	4,000	3,560	10,880
Total program	932,500	61,850	140,460	4,401,000	247,210	414,380	5,333,500	309,060	554,840
Federal	289,500	5,940	20,120	275,900	15,930	36,400	565,400	21,870	56,520
Non-Federal	643,000	55,910	120,340	4,125,100	231,280	377,980	4,768,100	287,190	498,320
1965-2020 Time frame									
Municipal & industrial	403,400	20,150		0	0		403,400	20,150	
Irrigation & drainage	439,200	8,260		369,500	20,650		808,700	28,910	
Electric power	1,118,700	24,770		4,658,400	272,260		5,777,100	297,030	
Flood control	286,800	3,400		0	0		286,800	3,400	
Outdoor recreation	83,500	1,160		1,011,900	103,910		1,095,400	105,070	
Fish and wildlife	27,200	200		100,100	7,510		127,300	7,710	
Water quality	263,200	68,340		0	0		263,200	68,340	
Land management	71,700	3,300		227,300	10,050		299,000	13,350	
Other development	26,700	10,880		0	0		26,700	10,880	
Total program	2,720,400	140,460		6,367,200	414,380		9,087,600	554,840	
Federal	1,238,300	20,120		702,600	36,400		1,940,900	56,520	
Non-Federal	1,482,100	120,340		5,664,600	377,980		7,146,700	498,320	

For comparison, average annual expenditures for the present "ongoing" programs were determined for the 1965-1969 period. Federal water development expenditures averaged $25 million annually. Non-Federal expenditures (State funds) averaged $3 million annually. Federal expenditures for "ongoing" associated development averaged $7 million annually. Non-Federal expenditures for associated development were not determined.

Subregional Plans

The six subregional plans are discussed on the following pages. These plans incorporate currently authorized projects, projects under investigation, and other features and programs required to meet the needs. The elements of the plans are discussed under three general categories: water, land, and other developments. Costs are divided between water and associated developments. Exchanges of resource use, necessary to meet subregional needs, are indicated. A plan to meet the requirements of OBE-ERS projections is presented. A complete analysis of alternate plans is not made, although alternates to some parts are discussed.

Bear River Subregion

The Bear River Subregion is a predominantly agricultural area and probably will remain so beyond 2020. About 25 percent of the Region's irrigated land is in this Subregion and produces 25 percent of the total value of agricultural output. Although producing only 2 percent of the Region's total mineral production, the Subregion contains large deposits of high grade phosphate rock.

Water Resources Development

Diversions for managed uses are planned to increase 448,000 acre-feet and depletions by 474,000 acre-feet by 2020, as shown in Table 47. Irrigated agriculture would require about 62 percent of the increased diversions, and municipal and industrial uses 36 percent. Fish and wildlife depletions are planned to increase by about 136,000 acre-feet by 2020 without additional diversions.

TABLE 47. PLANNED WATER USES - BEAR RIVER SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1000 acre-feet)		
Withdrawals					
Municipal and industrial	75	94	144	236	+ 161
Thermal electric power	0	0	7	5	+ 5
Recreation	1	2	2	3	+ 2
Minerals	1	2	2	3	+ 2
Irrigation	1,716	1,834	1,912	1,994	+ 278
Fish and wildlife	350	350	350	350	0
Total	2,143	2,282	2,417	2,591	+ 448
Depletions					
Municipal and industrial	24	30	58	116	+ 92
Thermal electric power	0	0	7	5	+ 5
Recreation	1	1	1	2	+ 1
Minerals	1	1	1	1	0
Irrigation	667	731	809	890	+ 223
Nonirrigated wet meadows	125	130	125	120	- 5
Managed fish and wildlife	169	220	267	305	+ 136
Unmanaged fish & wildlife and associated wetland	221	180	180	170	- 51
Reservoir evaporation	167	190	222	240	+ 73
Total	1,375	1,483	1,670	1,849	+ 474

The additional water requirements can be met with the present supply in the Subregion except for drought periods that may last for several years. During these periods, irrigation, and fish and wildlife uses may experience some shortage. The additional water supply can be developed by the following: (1) construction of reservoirs throughout the Bear River system to provide seasonal and long-term regulation, (2) construction of wells to provide ground water, principally for high quality municipal and industrial use, (3) more efficient use of diverted water, particularly for irrigation, and fish and wildlife, (4) reuse of return flows, and (5) conversion of unmanaged wetland use to managed fish and wildlife use. Table 48 shows sources of additional water supply.

TABLE 48. SOURCES OF ADDITIONAL WATER SUPPLY - BEAR RIVER SUBREGION

				Great Basin Region
Source of diversion	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acre-feet)		
Surface water 1/	135	120	160	415
Ground water 2/	4	15	14	33
Total	139	135	174	448

1/ Includes reuse of return flows.
2/ Includes some salvage from wetlands.

Municipal and industrial supplies would be from both surface water storage and ground water. Ground water would be utilized primarily in Cache Valley. Some streamflow exchanges would be required to assure the quality for most municipal and industrial uses.

Irrigation water will be supplied from surface water storage, return flows, and by increased efficiency of use. Table 49 shows the planned irrigation water use.

TABLE 49. PLANNED IRRIGATION WATER USE - BEAR RIVER SUBREGION

					Great Basin Region
	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Diversions					
Presently developed cropland	1,716	1,727	1,676	1,620	- 96
New cropland	-	107	236	374	+ 374
Total diversions	1,716	1,834	1,912	1,994	+ 278
Depletions					
Presently developed cropland	667	683	703	722	+ 55
New cropland	-	48	106	168	+ 168
Total depletions	667	731	809	890	+ 223

Table 50 shows the facilities associated with water development. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use.

TABLE 50. FACILITIES REQUIRED TO DEVELOP THE PLAN - BEAR RIVER SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	550	459	359	1,368
Conveyance facilities	miles	36	47	32	115
Pumping plants	number	0	2	1	3
Drainage	1000 acres	36	46	37	119
Water treatment	1000 AF.	3	14	21	38
Waste water treatment	1000 AF.	15	20	30	65

Land Resources Development

Land use changes planned for the 1965-2020 period are shown in Table 51. The largest increase is for outdoor recreation. Most of this increase would occur on forest and rangeland where concurrent uses are possible. The major decrease occurs in grazing land use, however, production on remaining grazing land increases by 227,000 AUMs. Development of new land for irrigation is planned to utilize the available water supply and to replace crop production on land lost to urban development in the Great Salt Lake Subregion. Table 52 shows the planned irrigated land development. Additional land for mineral production is planned and would require almost exclusive use. Other planned land use changes include classified watersheds, fish and wildlife, and water control reservoirs.

TABLE 51. PLANNED LAND USES - BEAR RIVER SUBREGION

Great Basin Region

Principal use[1/]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	497	529	565	600	+ 103
Dry cropland	527	522	540	580	+ 53
Grazing land	3,213	3,150	2,974	2,826	- 387
Timber	373	370	367	363	- 10
Urban and industrial	34	34	37	43	+ 9
Outdoor recreation	35	62	214	256	+ 221
Wilderness and scenic	35	45	45	45	+ 10
Flood control measures	7	9	13	14	+ 7
Military and related	0	0	0	0	0
Minerals	20	39	49	80	+ 60
Fish and wildlife	119	202	220	246	+ 127
Classified watershed	68	78	93	97	+ 29
Transportation and utilities	57	72	77	80	+ 23
Water control reservoirs	97	110	131	138	+ 41

1/ Multiple uses of land are made in most categories.

TABLE 52. PLANNED IRRIGATED LAND DEVELOPMENT - BEAR RIVER SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	497	497	529	565	-
Loss to other uses[1/]	-	-2	-4	-6	- 12
New land development[1/]	-	34	40	41	+ 115
Net developed land	497	529	565	600	+ 103
Idle land remaining	7	7	7	7	0
Productive land	490	522	558	593	+ 103

1/ Values are incremental amounts.

The watershed treatment program associated with the plan is shown in Table 53. The treatment on irrigated cropland involves improvement in drainage and water application. The dry cropland treatment includes erosion and sediment control, while on forest and rangeland the program is primarily land treatment measures.

TABLE 53. WATERSHED TREATMENT PROGRAM - BEAR RIVER SUBREGION

				Great Basin Region
Land resource group	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	114	127	134	375
Dry cropland	139	129	134	402
Forest and rangeland	600	755	590	1,945
Total	853	1,011	858	2,722

Other Resources Development

The flood control plan includes 227,000 acre-feet of reservoir storage, principally in multiple-use structures. About 40 percent will be developed by the year 2000. Table 54 shows the elements of the flood control plan.

TABLE 54. ELEMENTS OF THE FLOOD CONTROL PLAN - BEAR RIVER SUBREGION

					Great Basin Region
Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	24	180	23	227
Levees	miles	-	-	-	-
Channels	miles	3	12	7	22
Watershed treatment1/	1000 acres	12	12	12	36
Flood plain management	No. areas	-	2	2	4

1/ Included in watershed treatment program.

The Subregion contains suitable areas to meet the planned uses for the various classes of recreation except for Classes IV and V. These can be satisfied by Class III recreation resources, but the quality may be less. The present water surface area, with planned related development, is adequate to meet recreation demands. Upstream portions of both the Bear River and some of its tributaries will be included in the wild, scenic, or recreation river system. Big game and upland bird populations would remain almost constant through 2020 because of limited habitat. This will limit big game hunting. Waterfowl hunting demands will be met by management of additional wetland areas and regulation of diversions to managed wetland areas. This will assure delivery of water at the time and in the amounts needed.

A thermal-electric plant is planned on the lower reaches of the Bear River during the last time frame. During this same time period, a pumped storage facility is planned utilizing Bear Lake as the supply source and lower reservoir. No new conventional hydroelectric generating facilities are planned but present facilities would continue to operate.

The water quality problems are principally the result of discharge from mineralized springs in the lower Bear and Malad Rivers. These will be alleviated by releases from planned storage facilities during critical low-flow periods.

Effects of Development to Meet the Plan

The major effect of the plan is the increase in irrigated agriculture and the complementary activities of food processing and supporting services. The increase in storage facilities, planned to supply water principally for irrigated agriculture and waterfowl habitat, will also improve the quality of low flows in Malad River and the lower reaches of Bear River. The major effect of mineral activity will be phosphate rock beneficiation. The decrease in outflow of Bear River will have a major effect on the Great Salt Lake.

Costs

A summary of costs to meet the framework plan is shown in Table 55. An explanation of the various cost items is given under the regional plan discussion.

Water development costs would be about $648 million by 2020, and OM&R costs would be about $20 million annually. Recreation water development costs include a share of the costs for multiple-use storage facilities, whereas the plan indicates that no new water surface areas are required.

Total development costs, which include associated developments, would be about $1,235 million by 2020. OM&R costs would be about $52 million annually by the end of this period.

TABLE 55. COMPREHENSIVE FRAMEWORK PLAN COSTS - BEAR RIVER SUBREGION

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal-lation	OM&R Incr.	OM&R Cum.	Instal-lation	OM&R Incr.	OM&R Cum.	Instal-lation	OM&R Incr.	OM&R Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	7,800	200		0	0		7,800	200	
Irrigation & drainage	50,100	740		29,400	1,500		79,500	2,240	
Electric power	200	10		25,600	680		25,800	690	
Flood control	6,300	90		0	0		6,300	90	
Outdoor recreation	9,500	10		22,200	1,830		31,700	1,840	
Fish and wildlife	8,600	40		2,700	200		11,300	240	
Water quality	22,700	1,400		0	0		22,700	1,400	
Land management	2,300	90		8,200	310		10,500	400	
Other development	100	560		0	0		100	560	
Total program	107,600	3,140		88,100	4,520		195,700	7,660	
Federal	79,400	400		38,700	1,540		118,100	1,940	
Non-Federal	28,200	2,740		49,400	2,980		77,600	5,720	
1980-2000 Time frame									
Municipal & industrial	14,400	650	850	0	0	0	14,400	650	850
Irrigation & drainage	74,600	370	1,110	32,600	1,660	3,160	107,200	2,030	4,270
Electric power	4,000	150	160	320,200	18,330	19,010	324,200	18,480	19,170
Flood control	9,400	160	250	0	0	0	9,400	160	250
Outdoor recreation	5,200	10	20	35,900	3,060	4,890	41,100	3,070	4,910
Fish and wildlife	1,000	10	50	2,700	200	400	3,700	210	450
Water quality	3,600	2,200	3,600	0	0	0	3,600	2,200	3,600
Land management	2,700	140	230	9,500	460	770	12,200	600	1,000
Other development	100	580	1,140	0	0	0	100	580	1,140
Total program	115,000	4,270	7,410	400,900	23,710	28,230	515,900	27,980	35,640
Federal	63,300	620	1,020	48,800	2,300	3,840	112,100	2,920	4,860
Non-Federal	51,700	3,650	6,390	352,100	21,410	24,390	403,800	25,060	30,780
2000-2020 Time frame									
Municipal & industrial	32,400	1,100	1,950	0	0	0	32,400	1,100	1,950
Irrigation & drainage	57,500	300	1,410	34,000	1,770	4,930	91,500	2,070	6,340
Electric power	311,700	6,590	6,750	0	-2,600	16,410	311,700	3,990	23,160
Flood control	4,600	80	330	0	0	0	4,600	80	330
Outdoor recreation	9,800	10	30	47,800	4,150	9,040	57,600	4,160	9,070
Fish and wildlife	1,800	10	60	9,200	690	1,090	11,000	700	1,150
Water quality	5,800	3,700	7,300	0	0	0	5,800	3,700	7,300
Land management	1,900	60	290	7,100	210	980	9,000	270	1,270
Other development	200	570	1,710	0	0	0	200	570	1,710
Total program	425,700	12,420	19,830	98,100	4,220	32,450	523,800	16,640	52,280
Federal	76,800	550	1,570	53,500	2,700	6,540	130,300	3,250	8,110
Non-Federal	348,900	11,870	18,260	44,600	1,520	25,910	393,500	13,390	44,170
1965-2020 Time frame									
Municipal & industrial	54,600	1,950		0	0		54,600	1,950	
Irrigation & drainage	182,200	1,410		96,000	4,930		278,200	6,340	
Electric power	315,900	6,750		345,800	16,410		661,700	23,160	
Flood control	20,300	330		0	0		20,300	330	
Outdoor recreation	24,500	30		105,900	9,040		130,400	9,070	
Fish and wildlife	11,400	60		14,600	1,090		26,000	1,150	
Water quality	32,100	7,300		0	0		32,100	7,300	
Land management	6,900	290		24,800	980		31,700	1,270	
Other development	400	1,710		0	0		400	1,710	
Total program	648,300	19,830		587,100	32,450		1,235,400	52,280	
Federal	219,500	1,570		141,000	6,540		360,500	8,110	
Non-Federal	428,800	18,260		446,100	25,910		874,900	44,170	

Great Salt Lake Subregion

The Great Salt Lake Subregion is the most highly urbanized and industrialized area in the Region. Agriculture is also important, accounting for 21 percent of the irrigated land and 30 percent of the total value of gross agricultural output. Mineral production is 71 percent of the Regional total. These relationships are expected to continue.

Water Resources Development

Planned water uses, summarized in Table 56, indicate water withdrawals will increase about 1.1 MAF during the 1965-2020 period and depletions will increase about 0.6 MAF. The following sources of supply were considered in meeting these needs: (1) continued development of local surface and ground-water supplies, (2) importation of water from the Upper Colorado Region under authorized projects, (3) improving water use efficiencies, (4) salvaging water consumed for nonbeneficial uses, (5) increasing the use of return flows, (6) converting water to new uses consistent with associated changes in land use, (7) desalting residual flows, or additional importation of water from the Upper Colorado Region.

Comparisons of diversion requirements with the water supplies available were made on the basis of water quality required and availability of water in close proximity to the uses. Two means of meeting the water supply needs are presented for the last time frame. One would provide high quality water by importation from the Upper Colorado Region. The other would limit imports to currently authorized projects and would depend on desalting residual flows to supply the high quality water. The State of Utah is presently studying these and other alternative plans. The desalting or import quantity is the residual demand after considering local resources and authorized imports. Cursory investigations show these alternates to be competitive.

Increased diversions by 2020 from potable water supply sources total 578,000 acre-feet. These diversions are for municipal and industrial use, 571,000 acre-feet, and recreation use, 7,000 acre-feet. Sources for these diversions are shown in Table 57.

TABLE 56. PLANNED WATER USES - GREAT SALT LAKE SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Withdrawals					
Municipal & industrial	319	497	832	1,345	+1,026
Thermal electric power	5	5	5	73	+ 68
Recreation	3	6	10	18	+ 15
Minerals 1/	72	111	123	141	+ 69
Irrigation	1,573	1,496	1,405	1,361	- 212
Fish and wildlife 2/	255	272	295	380	+ 125
Total	2,227	2,387	2,670	3,318	+1,091
Depletions					
Municipal & industrial	103	175	340	647	+ 544
Thermal electric power	5	5	5	73	+ 68
Recreation	1	2	4	8	+ 7
Minerals 1/	8	14	16	18	+ 10
Irrigation	651	648	638	648	- 3
Nonirrigated wet meadows	310	285	255	235	- 75
Managed fish & wildlife 2/	165	182	212	322	+ 157
Unmanaged fish & wildlife & associated wetland	91	91	91	46	- 45
Reservoir evaporation	303	241	251	263	- 40
Total	1,637	1,643	1,812	2,260	+ 623

1/ Excludes water used for copper smelter which is included in M&I
2/ Values adjusted in framework plan formulation.

TABLE 57. SOURCES OF ADDITIONAL POTABLE WATER SUPPLIES - GREAT SALT LAKE SUBREGION

Great Basin Region

Source of diversion	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acre-feet)		
Developed water, unused in 1965 1/	32	57	5	94
Ground water	5	26	50	81
Surface water	11	19	22	52
Authorized import - Upper Colorado Region	30	53	17	100
Irrigation conversion to municipal use	21	34	47	102
Salvage	4	6	8	18
Desalting or additional imports from Upper Colorado Region	0	0	131	131
Total	103	195	280	578

1/ Values show when use is planned.

Increased diversions by 2020 from nonpotable water supply sources total 725,000 acre-feet. These diversions are 455,000 acre-feet for industrial uses, 68,000 acre-feet for power production, 69,000 acre-feet for mineral production, 125,000 acre-feet for fish and wildlife use, and 8,000 acre-feet for recreation. Table 58 lists the sources of these diversions.

TABLE 58. SOURCES OF ADDITIONAL NONPOTABLE WATER SUPPLIES - GREAT SALT LAKE SUBREGION

				Great Basin Region
Source of diversion	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acre-feet)		
Developed water, unused in 1965 1/	56	30	0	86
Ground water	0	0	40	40
Surface water	0	40	40	80
Irrigation conversion	17	23	55	95
Municipal & industrial return flow	61	86	277	424
Total	134	179	412	725

1/ Values show when use is planned.

The fish and wildlife use, principally water consumption on waterfowl areas, is predominantly along the east shore of Great Salt Lake where unused surface water and return flows accumulate.

Development of irrigation water is planned to supply the new land that replaces irrigated land converted to other uses. Although net irrigation diversion requirements decline 212,000 acre-feet by the year 2020, about 345,000 acre-feet of water would be required to irrigate this new land. About 156,000 acre-feet of this requirement will be developed under authorized Upper Colorado Region imports. Table 59 shows the planned irrigation water use.

TABLE 59. PLANNED IRRIGATION WATER USE - GREAT SALT LAKE SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Diversions					
Presently developed cropland 1/	1,573	1,425	1,258	1,018	- 555
New cropland	0	71	147	343	+ 343
Total diversions	1,573	1,496	1,405	1,361	- 212
Depletions					
Presently developed cropland 1/	651	616	572	494	- 157
New cropland	0	32	66	154	+ 154
Total depletions	651	648	638	648	- 3

1/ Includes water for idle land returned to production.

Facilities associated with water resource developments are summarized by time frames in Table 60, which includes facilities for the importation alternative. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use.

TABLE 60. FACILITIES REQUIRED TO DEVELOP THE PLAN - GREAT SALT LAKE SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	570	142	180	892
Conveyance facilities	miles	190	40	150	380
Pumping plants	number	4	0	5	9
Irrigation laterals	1000 acres	43	21	25	89
Drainage	1000 acres	13	17	17	47
Water treatment	1000 AF.	100	175	215	490
Waste water treatment	1000 AF.	105	175	215	495

Land Resources Development

Land required to meet the plan for the 1965-2020 period, results in several significant changes in land use. These are shown in Table 61. The most important impacts are from expanding urban and industrial requirements. Other major adjustments include increased mineral land use and decreased grazing land acreage. Production on remaining grazing land would increase by 385,000 AUMs.

TABLE 61. PLANNED LAND USES - GREAT SALT LAKE SUBREGION

Great Basin Region

Principal use[1/]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	452	425	389	368	- 84
Dry cropland	410	408	403	419	+ 9
Grazing land	12,480	12,323	12,212	12,069	- 411
Timber	1,093	1,087	1,077	1,068	- 25
Urban and industrial	148	201	267	354	+ 206
Outdoor recreation	92	113	175	215	+ 123
Wilderness and scenic	25	127	127	127	+ 102
Flood control measures	10	14	20	23	+ 13
Military and related	1,861	1,861	1,861	1,861	0
Minerals	157	371	431	501	+ 344
Fish and wildlife	180	302	330	366	+ 186
Classified watershed	134	154	174	184	+ 50
Transportation and utilities	134	174	204	225	+ 91
Water control reservoirs	109	84[2/]	88	91	- 18

1/ Multiple uses of land are made in most categories.
2/ Includes 34,000-acre reduction for diking of Utah Lake.

Loss of irrigated land to other uses, primarily urban and industrial, requires development of replacement lands. Table 62 shows the planned irrigated land development. Adequate arable land is available but remotely removed from water supplies. For this reason, the plan shifts production on 55,000 acres of irrigated land to the Bear River Subregion and on 30,000 acres to the Sevier Lake Subregion. An alternate solution would transfer about 200,000 acre-feet of water from the Bear River Subregion to irrigate the 55,000 acres or increase imports from the Upper Colorado Region by a similar amount.

TABLE 62. PLANNED IRRIGATED LAND DEVELOPMENT - GREAT SALT LAKE SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	452	452	425	389	-
Loss to other uses1/	-	-47	-56	-70	- 173
New land development1/	-	20	20	49	+ 89
Net developed land	452	425	389	368	- 84
Idle land remaining	26	20	14	8	+ 18 2/
Productive land	426	405	375	360	- 66

1/ Values are incremental amounts.
2/ Idle land restored to production.

The watershed treatment program associated with the plan is shown in Table 63. Irrigated cropland treatment involves improved water application and drainage. The dry cropland treatment includes erosion and sediment control while the program on forest and rangeland is primarily land treatment measures.

TABLE 63. WATERSHED TREATMENT PROGRAM - GREAT SALT LAKE SUBREGION

Great Basin Region

Land resource group	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	75	110	98	283
Dry cropland	126	95	95	316
Forest and rangeland	2,200	3,980	2,300	8,480
Total	2,401	4,185	2,493	9,079

Other Resources Development

The flood control plan consists of 247,000 acre-feet of reservoir storage, of which 230,000 acre-feet is multiple-use and 17,000 acre-feet is specifically for flood control. The elements of the flood control plan are shown in Table 64. A large increase in the flood forecasting program is included in the plan.

TABLE 64. ELEMENTS OF THE FLOOD CONTROL PLAN - GREAT SALT LAKE SUBREGION

					Great Basin Region
Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	159	80	8	247
Levees	miles	11	0	3	14
Channels	miles	73	22	8	103
Watershed treatment 1/	1000 acres	77	85	83	245
Flood plain management	No. areas	3	7	8	18

1/ Included in watershed treatment program.

Land-based recreation opportunities would be provided by established parks and other recreation areas within urban centers, providing recreation facilities at designated open space and flood plain management areas, and adjacent to water resource developments. Other land-related recreation would include hiking trails, historical sites, scenic areas, and other attractions.

The water-based recreation plan includes improved access to existing water bodies and related development around these areas. This requires upgrading the water quality of Utah Lake and Jordan River. Diking and stabilizing portions of Great Salt Lake could increase its recreational use. Suitable segments of the Jordan River flood plain would be utilized as greenbelt recreation areas. Portions of the Provo and Weber Rivers would be included in a wild, scenic, or recreation river system.

Better management practices for fish and wildlife purposes are essential and will be implemented. Planned water storage facilities will provide adequate reservoir fisheries. A program to effectively combat deterioration of Utah Lake and Jordan River as fishing waters is included. An additional 125,000 acre-feet of water will be diverted to fish and wildlife uses, principally for managed waterfowl areas. About 186,000 acres of additional land will be developed for wildlife habitat, primarily winter range.

Electric power facilities planned prior to the year 2000 would include hydroelectric power plants using authorized Colorado River water imports, and about 30,000 acre-feet of pumped storage capacity. A large nuclear plant is planned at Little Mountain near the shores of Great Salt Lake in the last time frame. Imports would still be required.

Treatment of municipal and industrial return flows is an essential part of the plan to permit reuse. At least secondary treatment is planned for all municipalities. Advanced treatment is proposed for the Jordan River Basin and the Weber River Basin to maintain an acceptable level of water quality for the general well-being of the people including opportunities for water-related recreation.

Effects of Development to Meet the Plan

The population of the Subregion is expected to triple by 2020 and continue to be concentrated along the Wasatch Front. This will increase the need for potable water. The demand for high quality municipal and industrial water will require many present uses to be satisfied by lower quality water. Continuing development of surface and ground-water supplies, as well as authorized imports, will be necessary. In the final time frame either additional imports or the reclaiming of brackish water will be required. Inflow to Great Salt Lake will decrease and cause further long-term decline in the lake level.

Population growth will increase the urban and industrial use of land presently being used for irrigation. To meet food and fiber requirements allocated to this Subregion, production on about 85,000 acres was shifted to neighboring subregions.

Mining will require one of the largest increases in land use, however, only about 10 percent of this land surface will be disturbed by the mining process. The planned use of land for other purposes will decrease the amount of land available for grazing.

Urban and industrial expansion will result in water, air and land pollution problems. Location of a nuclear power plant in the Subregion is of concern. If the plant is located at the Little Mountain site, relatively remote from population centers and with proper waste disposal, problems will be diminished.

Costs

A summary of costs to meet the framework plan for the Great Salt Lake Subregion is presented in Table 65. An explanation of the various cost items is given under the regional plan discussion.

Water development costs would be about $1,235 million by 2020, and OM&R costs would be about $80 million annually. Costs would be about the same for importing additional water or desalting residual flows.

TABLE 65. COMPREHENSIVE FRAMEWORK PLAN COSTS - GREAT SALT LAKE SUBREGION

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal-	OM&R		Instal-	OM&R		Instal-	OM&R	
	lation	Incr.	Cum.	lation	Incr.	Cum.	lation	Incr.	Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	92,200	3,520		0	0		92,200	3,520	
Irrigation & drainage	68,800	2,980		25,600	1,600		94,400	4,580	
Electric power	228,500	4,950		25,600	680		254,100	5,630	
Flood control	36,800	410		0	0		36,800	410	
Outdoor recreation	24,300	200		92,200	13,160		116,500	13,360	
Fish and wildlife	7,300	40		9,500	710		16,800	750	
Water quality	33,600	7,900		0	0		33,600	7,900	
Land management	4,400	250		14,500	790		18,900	1,040	
Other development	14,400	1,540		0	0		14,400	1,540	
Total program	510,300	21,790		167,400	16,940		677,700	38,730	
Federal	281,500	2,850		35,600	1,590		317,100	4,440	
Non-Federal	228,800	18,940		131,800	15,350		360,600	34,290	
1980-2000 Time frame									
Municipal & industrial	54,000	3,080	6,600	0	0	0	54,000	3,080	6,600
Irrigation & drainage	29,100	410	3,390	37,100	2,110	3,710	66,200	2,520	7,100
Electric power	314,900	7,250	12,200	150,900	19,350	20,030	465,800	26,600	32,230
Flood control	28,600	360	770	0	0	0	28,600	360	770
Outdoor recreation	8,600	40	240	174,800	19,650	32,810	183,400	19,690	33,050
Fish and wildlife	2,700	10	50	9,500	710	1,420	12,200	720	1,470
Water quality	39,000	13,100	21,000	0	0	0	39,000	13,100	21,000
Land management	5,900	220	470	19,300	670	1,460	25,200	890	1,930
Other development	900	1,770	3,310	0	0	0	900	1,770	3,310
Total program	483,700	26,240	48,030	391,600	42,490	59,430	875,300	68,730	107,460
Federal	248,100	4,780	7,630	78,300	4,100	5,690	326,400	8,880	13,320
Non-Federal	235,600	21,460	40,400	313,300	38,390	53,740	548,900	59,850	94,140
2000-2020 Time frame									
Municipal & industrial	121,300	7,860	14,460	0	0	0	121,300	7,860	14,460
Irrigation & drainage	44,100	1,300	4,690	33,500	2,150	5,860	77,600	3,450	10,550
Electric power	3,900	60	12,260	2,521,000	132,120	152,150	2,524,900	132,180	164,410
Flood control	13,800	310	1,080	0	0	0	13,800	310	1,080
Outdoor recreation	3,300	20	260	264,100	29,340	62,150	267,400	29,360	62,410
Fish and wildlife	500	10	60	16,000	1,200	2,620	16,500	1,210	2,680
Water quality	50,600	20,600	41,600	0	0	0	50,600	20,600	41,600
Land management	3,400	220	690	11,500	670	2,130	14,900	890	2,820
Other development	300	1,760	5,070	0	0	0	300	1,760	5,070
Total program	241,200	32,140	80,170	2,846,100	165,480	224,910	3,087,300	197,620	305,080
Federal	137,800	3,070	10,700	89,700	5,860	11,550	227,500	8,930	22,250
Non-Federal	103,400	29,070	69,470	2,756,400	159,620	213,360	2,859,800	188,690	282,830
1965-2020 Time frame									
Municipal & industrial	267,500	14,460		0	0		267,500	14,460	
Irrigation & drainage	142,000	4,690		96,200	5,860		238,200	10,550	
Electric power	547,300	12,260		2,697,500	152,150		3,244,800	164,410	
Flood control	79,200	1,080		0	0		79,200	1,080	
Outdoor recreation	36,200	260		531,100	62,150		567,300	62,410	
Fish and wildlife	10,500	60		35,000	2,620		45,500	2,680	
Water quality	123,200	41,600		0	0		123,200	41,600	
Land management	13,700	690		45,300	2,130		59,000	2,820	
Other development	15,600	5,070		0	0		15,600	5,070	
Total program	1,235,200	80,170		3,405,100	224,910		4,640,300	305,080	
Federal	667,400	10,700		203,600	11,550		871,000	22,250	
Non-Federal	567,800	69,470		3,201,500	213,360		3,769,300	282,830	

Recreation water development costs include a share of the costs for multiple use storage facilities, whereas the plan indicates that no new water surface areas are required.

Total development costs, which include associated developments, would be about $4,640 million by 2020. OM&R costs would be about $305 million annually at the end of this period.

Alternative Level of Municipal and Industrial Water Use

The use of municipal water is projected to increase from 0.22 acre-feet per capita in 1965 to 0.28 acre-feet by 2020. The rate in the major urban areas has remained almost constant for the past ten years. If the present rate of 0.22 acre-feet were to continue through 2020, about 140,000 acre-feet less diversions of high quality water would be needed. This would eliminate the need for additional imports or desalting as shown in the plan for the final time frame.

The alternative method of projecting water requirements for the industrial sector is based on employment in manufacturing rather than total economic output. Applying the alternative method would reduce industrial intake requirements by about 260,000 acre-feet and depletions by 285,000 acre-feet.

These reductions in use would allow meeting the irrigation requirements without shifting production to neighboring subregions. The inflow to Great Salt Lake would be greater than under the plan.

Opportunities for Managing Great Salt Lake

Although water laws and Utah State policy indicate that inflows to the Great Salt Lake will be dictated for the most part by upstream uses, there remains considerable latitude for managing the water surface area of the lake. Through such management, significant mineral, recreational and esthetic benefits can be realized.

Numerous diking plans have been proposed in the past. One plan[1/] suggests dikes from Antelope Island to Fremont Island, and then to Promontory Point. The estimated cost of this dike is $9 million (1965 dollars). Approximately 155,000 acres of water surface would lie east of this dike if the water were at an elevation of 4200 feet above sea level.

1/ Advisory Committee to State Road Commission of Utah, 1958. Great Salt Lake diking study.

Another proposal[2/] suggests a dike from Stansbury Island through Carrington Island and Bird Island to Promontory Point. The estimated cost of this dike is $35 million (1965 dollars). About 333,000 acres of water surface would lie east of this dike at the same elevation. The Southern Pacific causeway from Little Mountain to Promontory Point to Lakeside is partially effective as a dike, as is the road from Syracuse to the north end of Antelope Island. Figure 6 shows the location of these dikes.

The various diking plans would not necessarily be mutually exclusive. It has been suggested that the area east of Antelope Island be reserved for fresh water recreation and possibly some residential landfill. The area between Antelope and Stansbury Islands could be used for the unique recreational experiences offered by a highly saline water body. The entire western portion of the lake could be used for mineral extraction. The three separate bodies of water would be at different elevations.

Water surface area in 1965 was 670,000 acres at elevation 4193.75 feet. The available water supply will dictate future water surface elevations and location of dikes. Under the framework plan, the inflow to the lake will be reduced to about 635,000 acre-feet under the import alternative and 504,000 acre-feet under the desalting alternative. The 2020 water supply could maintain an average area of 238,000 acres under the import alternative and 188,000 acres under the desalting alternative.

The following tabulation shows the inflows, areas, volumes, and water surface elevations for various conditions and alternatives. Elevations were selected to maintain a constant level in the fresh water bay to provide fish, wildlife, and recreation uses, and in the saline bay to enhance its unique uses.

2/ Caldwell, Richards and Sorensen, 1965. A preliminary master plan for the development of the Great Salt Lake. Salt Lake City, Utah, 32 p.

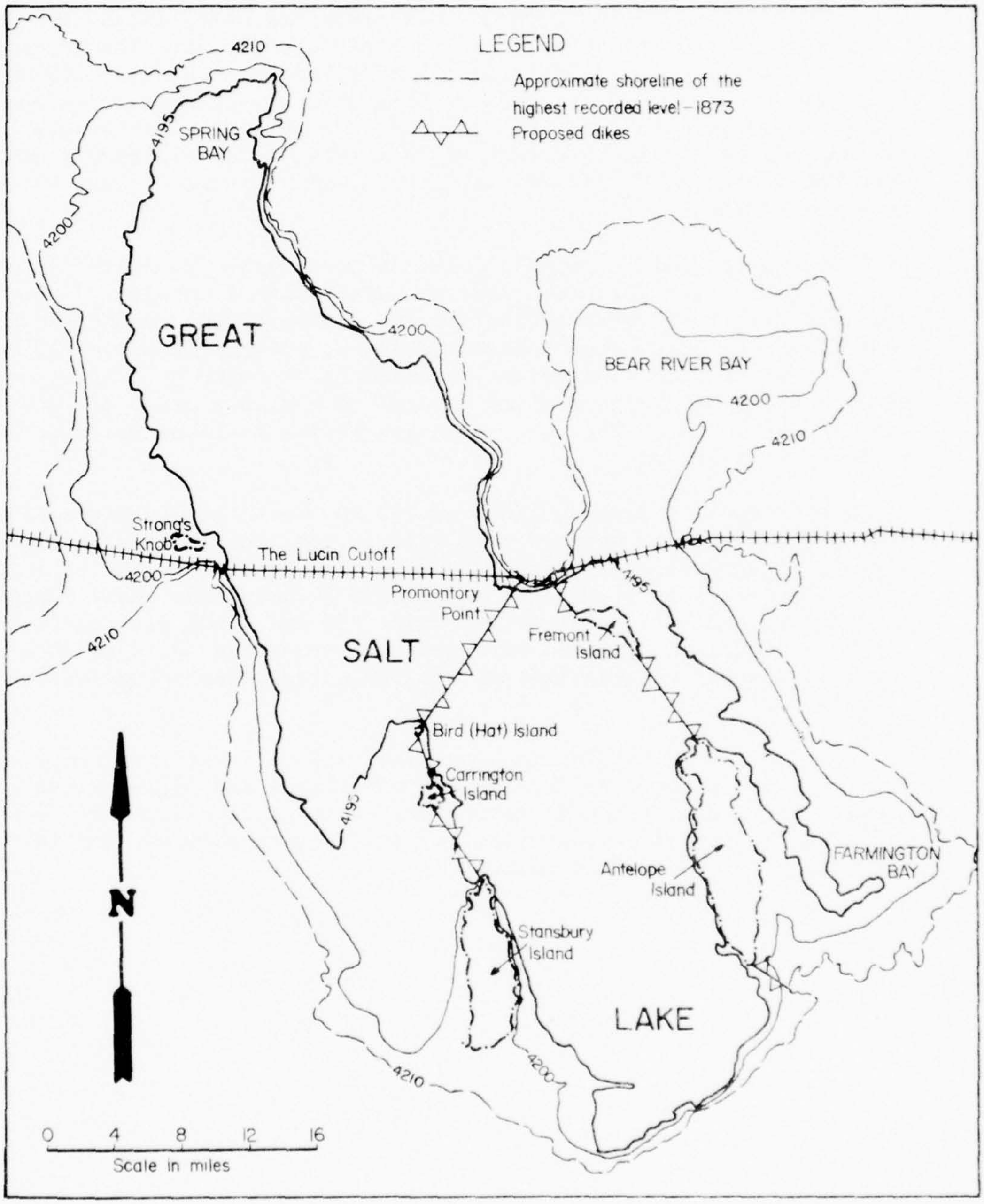


Figure 6. Proposed diking - Great Salt Lake

Condition	Inflow (ac-ft)	Area (acres)	Volume (ac-ft)	Elevation (feet)
Present - 1965	1,500,000	561,900	7,500,000	4189.3
Future - 2020, without dikes				
Import alternative	635,000	238,000	880,000	4173.7
Desalting alternative	504,000	188,000	540,000	4172.2
Future - 2020, with dikes				
Fresh water bay				
Import alternative	635,000	50,400	160,000	4195.0
Desalting alternative	504,000	50,400	160,000	4195.0
Saline bay				
Import alternative	635,000	211,000	654,000	4184.0
Desalting alternative	504,000	159,000	524,000	4178.0

Before any diking plan could be initiated, considerable legal, economic, and financial obstacles would have to be overcome. The most serious relate to existing mineral leases covering the lakebed, and the tremendous cost of any diking program. Most of the companies holding leases have either constructed or plan to construct facilities to extract salts from the lake brine. These are based on future lake stages not influenced by diking. Nearly all diking programs would increase mineral recovery costs.

Sevier Lake Subregion

This subregion is predominantly agricultural and is expected to remain so. The population is projected to decrease but employment would remain essentially the same.

Water Resources Development

Planned water uses are shown in Table 66. Withdrawals are expected to increase 161,000 acre-feet and depletions 96,000 acre-feet by 2020. More than 90 percent would be for irrigated agriculture. The additional water supply can be developed by the following: (1) additional surface water storage for seasonal regulation, principally on headwater and smaller tributary drainages, (2) improved long-term management of ground-water reservoirs with some allowable short-term mining, (3) importation of water primarily into the Sevier River drainage, and (4) salvage from wetlands by pumping, drainage, and increased irrigation efficiencies. Table 67 shows the sources of supply.

TABLE 66. PLANNED WATER USES - SEVIER LAKE SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Withdrawals					
Municipal & industrial	20	23	25	28	+ 8
Thermal electric power	0	0	0	0	0
Recreation	1	1	2	2	+ 1
Minerals	1	2	3	3	+ 2
Irrigation	1,320	1,350	1,403	1,470	+ 150
Fish and wildlife	55	55	55	55	0
Total	1,397	1,431	1,488	1,558	+ 161
Depletions					
Municipal & industrial	7	8	10	12	+ 5
Thermal electric power	0	0	0	0	0
Recreation	1	1	1	1	0
Minerals	1	1	2	2	+ 1
Irrigation	600	618	663	710	+ 110
Nonirrigated wet meadows	190	177	165	165	- 25
Managed fish & wildlife	55	55	55	55	0
Unmanaged fish & wildlife & associated wetland	47	47	47	47	0
Reservoir evaporation	70	70	75	75	+ 5
Total	971	977	1,018	1,067	+ 96

TABLE 67. SOURCES OF ADDITIONAL WATER SUPPLIES - SEVIER LAKE SUBREGION

Great Basin Region

Source of diversion	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acre-feet)		
Surface water	0	20	0	20
Ground water	20	3	7	30
Authorized imports	0	30 1/	35 2/	65
Salvage 3/	14	4	28	46
Total	34	57	70	161

1/ Excludes 6,000 AF. conveyance loss.
2/ Excludes 5,000 AF. conveyance loss.
3/ Includes reuse of return flows.

The planned irrigation water use is shown in Table 68. Imports during the 1980-2000 time frame would be high quality water from the Upper Colorado Region. These would be used primarily in the lower reaches of the Sevier River drainage but would permit additional uses upstream through exchange. High quality imports would also upgrade the surface supplies. The imports in the final time frame would be lower quality water from Utah Lake in the Great Salt Lake Subregion.

TABLE 68. PLANNED IRRIGATION WATER USE - SEVIER LAKE SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Diversions					
Presently developed cropland 1/	1,320	1,350	1,368	1,408	+ 88
New cropland	-	-	35	62	+ 62
Total diversions	1,320	1,350	1,403	1,470	+ 150
Depletions					
Presently developed cropland 1/	600	618	647	682	+ 82
New cropland	-	-	16	28	+ 28
Total depletions	600	618	663	710	+ 110

1/ Includes water for idle land returned to production.

The water requirements for all uses other than agriculture generally would be obtained from ground water. The municipal and industrial requirements in the Cedar City area, after the first time frame, would be met by surface water diversions from the upper reaches of the Sevier River, or by surface water imports from the Virgin River drainage.

Table 69 shows the facilities associated with water development. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use.

TABLE 69. FACILITIES REQUIRED TO DEVELOP THE PLAN - SEVIER LAKE SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	20	80	2	102
Conveyance facilities	miles	0	59	63	122
Pumping plants	number	0	1	3	4
Irrigation laterals	1000 acres	0	8	6	14
Drainage	1000 acres	4	6	5	15
Water treatment	1000 AF.	0	3	0	3
Waste water treatment	1000 AF.	2	1	1	4

Land Resources Development

Planned land uses are shown in Table 70. All projected needs for land can be met. The dry cropland increase of 7,000 acres would occur in the northeast portion of the Subregion where climatic conditions are favorable. Grazing land acreage will decrease; however, production on remaining land will increase about 301,000 AUMs.

TABLE 70. PLANNED LAND USES - SEVIER LAKE SUBREGION

Great Basin Region

Principal use 1/	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	378	374	380	385	+ 7
Dry cropland	146	144	139	153	+ 7
Grazing land	8,004	7,960	7,908	7,867	- 137
Timber	777	771	764	758	- 19
Urban and industrial	19	19	19	19	0
Outdoor recreation	82	111	133	142	+ 60
Wilderness and scenic	0	53	53	53	+ 53
Flood control measures	9	17	24	30	+ 21
Military and related	0	0	0	0	0
Minerals	30	41	45	49	+ 19
Fish and wildlife	99	168	183	199	+ 100
Classified watershed	53	58	65	79	+ 26
Transportation and utilities	112	123	130	134	+ 22
Water control reservoirs	18	19	23	23	+ 5

1/ Multiple uses of land are made in most categories.

Table 71 shows planned irrigated land development. New land development and restoration of idle land would occur principally along the Sevier River system. This includes replacement of land lost to other uses and land necessary to meet production shifted from Great Salt Lake Subregion.

TABLE 71. PLANNED IRRIGATED LAND DEVELOPMENT - SEVIER LAKE SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	378	378	374	380	-
Loss to other uses 1/	-	-4	-2	-1	- 7
New land development 1/	-	-	8	6	+ 14
Net developed land	378	374	380	385	+ 7
Idle land remaining	53	49	40	30	+ 23 2/
Productive land	325	325	340	355	+ 30

1/ Values are incremental amounts.
2/ Idle land restored to production.

The watershed treatment program associated with the plan is shown in Table 72. The treatment on irrigated cropland involves improvement in drainage and water application. The dry cropland treatment includes erosion and sediment control while the program on forest and rangeland is primarily land treatment measures.

TABLE 72. WATERSHED TREATMENT PROGRAM - SEVIER LAKE SUBREGION

Great Basin Region

Land resource group	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	60	84	83	227
Dry cropland	33	36	36	105
Forest and rangeland	2,280	1,990	1,660	5,930
Total	2,373	2,110	1,779	6,262

Other Resources Development

The flood control plan includes watershed treatment, flood plain management, improved flood forecasting, and structural measures. Flood control storage capacity would be increased by 51,000 acre-feet.

principally in small multiple-use structures. Table 73 shows the elements of the flood control plan.

TABLE 73. ELEMENTS OF THE FLOOD CONTROL PLAN - SEVIER LAKE SUBREGION

					Great Basin Region
Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	20	29	2	51
Levees	miles	7	0	5	12
Channels	miles	10	2	2	14
Watershed treatment[1/]	1000 acres	79	87	87	253
Flood plain management	No. areas	0	2	0	2

1/ Included in watershed treatment program.

Planned recreation will be satisfied primarily on recreation Class III lands, which can accommodate multiple uses. Suitable areas will be designated as scenic or wilderness areas, including House and Mineral Ranges. Portions of Assay Creek and Beaver River will be considered as free-flowing streams because of their recreational and scenic value. Continued management, for wildlife purposes, is planned with special emphasis on preserving vital big game range. The multiple-use concept on public lands will be continued.

The plan will provide secondary sewage treatment for existing communities. There is a serious water quality problem on the Sevier River resulting from irrigation, return flows, and from natural sources, principally exposed Arapien shale in the central reach of the river. This problem will be met under the plan by timed storage releases, imports, and impoundment and evaporation of highly concentrated late season flows from one tributary.

Effects of Development to Meet the Plan

The major effect of the plan is to stabilize the present agricultural economy by better regulation of streamflow and better utilization of the available water resources. The economy of the present population will be improved. The tourist and hunting opportunities will be enhanced by the improvement in scenic and recreation areas and enlargement of big game habitat.

Costs

A summary of costs to meet the framework plan for the Sevier Lake Subregion is presented in Table 74. An explanation of the various cost items is given under the regional plan discussion.

TABLE 74. COMPREHENSIVE FRAMEWORK PLAN COSTS - SEVIER LAKE SUBREGION

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal-	OM&R		Instal-	OM&R		Instal-	OM&R	
	lation	Incr.	Cum.	lation	Incr.	Cum.	lation	Incr.	Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	500	30		0	0		500	30	
Irrigation & drainage	11,200	210		23,000	1,050		34,200	1,260	
Electric power	0	0		0	0		0	0	
Flood control	14,700	230		0	0		14,700	230	
Outdoor recreation	1,700	110		2,100	460		3,800	570	
Fish and wildlife	100	10		5,900	450		6,000	460	
Water quality	30,200	300		0	0		30,200	300	
Land management	8,000	290		24,500	860		32,500	1,150	
Other development	100	310		0	0		100	310	
Total program	66,500	1,490		55,500	2,820		122,000	4,310	
Federal	43,700	570		32,400	990		76,100	1,560	
Non-Federal	22,800	920		23,100	1,830		45,900	2,750	
1980-2000 Time frame									
Municipal & industrial	9,000	110	140	0	0	0	9,000	110	140
Irrigation & drainage	24,700	270	480	34,100	1,570	2,620	58,800	1,840	3,100
Electric power	0	0	0	0	0	0	0	0	0
Flood control	14,300	220	450	0	0	0	14,300	220	450
Outdoor recreation	2,000	20	130	1,900	180	640	3,900	200	770
Fish and wildlife	400	10	20	5,900	450	900	6,300	460	920
Water quality	600	600	900	0	0	0	600	600	900
Land management	8,700	300	590	26,600	890	1,750	35,300	1,190	2,340
Other development	100	200	510	0	0	0	100	200	510
Total program	59,800	1,730	3,220	68,500	3,090	5,910	128,300	4,820	9,130
Federal	39,700	460	1,030	38,200	980	1,970	77,900	1,440	3,000
Non-Federal	20,100	1,270	2,190	30,300	2,110	3,940	50,400	3,380	6,130
2000-2020 Time frame									
Municipal & industrial	500	30	170	0	0	0	500	30	170
Irrigation & drainage	25,800	670	1,150	33,900	1,520	4,140	59,700	2,190	5,290
Electric power	0	0	0	0	0	0	0	0	0
Flood control	9,600	270	720	0	0	0	9,600	270	720
Outdoor recreation	0	0	130	12,900	1,010	1,650	12,900	1,010	1,780
Fish and wildlife	100	10	30	5,900	450	1,350	6,000	460	1,380
Water quality	600	1,400	2,300	0	0	0	600	1,400	2,300
Land management	7,500	230	820	23,000	700	2,450	30,500	930	3,270
Other development	100	200	710	0	0	0	100	200	710
Total program	44,200	2,810	6,030	75,700	3,680	9,590	119,900	6,490	15,620
Federal	26,700	640	1,670	48,500	1,800	3,770	75,200	2,440	5,440
Non-Federal	17,500	2,170	4,360	27,200	1,880	5,820	44,700	4,050	10,180
1965-2020 Time frame									
Municipal & industrial	10,000	170		0	0		10,000	170	
Irrigation & drainage	61,700	1,150		91,000	4,140		152,700	5,290	
Electric power	0	0		0	0		0	0	
Flood control	38,600	720		0	0		38,600	720	
Outdoor recreation	3,700	130		16,900	1,650		20,600	1,780	
Fish and wildlife	600	30		17,700	1,350		18,300	1,380	
Water quality	31,400	2,300		0	0		31,400	2,300	
Land management	24,200	820		74,100	2,450		98,300	3,270	
Other development	300	710		0	0		300	710	
Total program	170,500	6,030		199,700	9,590		370,200	15,620	
Federal	110,100	1,670		119,100	3,770		229,200	5,440	
Non-Federal	60,400	4,360		80,600	5,820		141,000	10,180	

Water development costs would be about $170 million by 2020, and OM&R costs would be about $6 million annually.

Total development costs, which include associated development, would be about $370 million by 2020. OM&R costs would be about $16 million annually at the end of this period.

Humboldt Subregion

The Humboldt Subregion is predominantly an agricultural and mining area and will remain so through 2020. Most of the agricultural activity is associated with the livestock industry.

Water Resources Development

The 2020 water needs, shown in Table 75, are planned to increase by 251,000 acre-feet for withdrawals, and 100,000 acre-feet for depletions. About 67 percent of the additional withdrawals will be for irrigation. A large portion of the increased depletions on presently irrigated land will be satisfied by decreased use on nonirrigated wet meadows and increased efficiency on irrigated native hay and pasture. Diversions of 62,000 acre-feet to new cropland will be met almost entirely from ground water. Table 76 shows the planned irrigation water use.

TABLE 75. PLANNED WATER USES - HUMBOLDT SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
		(1,000 acre-feet)			
Withdrawals					
Municipal & industrial	12	14	18	25	+ 13
Thermal electric power 1/	0	0	18	8	+ 8
Recreation	1	1	1	1	0
Minerals	2	8	13	17	+ 15
Irrigation	929	915	1,011	1,100	+ 171
Fish and wildlife 1/	25	33	59	69	+ 44
Total	969	971	1,120	1,220	+ 251
Depletions					
Municipal & industrial	4	5	6	9	+ 5
Thermal electric power 1/	0	0	18	8	+ 8
Recreation	1	1	1	1	0
Minerals	1	5	7	10	+ 9
Irrigation	375	375	424	479	+ 104
Nonirrigated wet meadows	335	335	290	255	- 80
Managed fish & wildlife 1/	25	33	59	69	+ 44
Reservoir evaporation	20	30	30	30	+ 10
Total	761	784	835	861	+ 100

1/ Values adjusted in framework plan formulation.

TABLE 76. PLANNED IRRIGATION WATER USE - HUMBOLDT SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
		(1,000 acre-feet)			
Diversions					
Presently developed cropland	929	915	1,011	1,038	+ 109
New cropland	-	0	0	62	+ 62
Total diversions	929	915	1,011	1,100	+ 171
Depletions					
Presently developed cropland	375	375	424	451	+ 76
New cropland	-	0	0	28	+ 28
Total depletions	375	375	424	479	+ 104

Wild flooding of native hay and pasture is the main type of irrigation practiced above Rye Patch Reservoir. Fields are flooded in the spring until streamflows diminish. Major improvements are not presently feasible in these areas of highly variable streamflows and short growing seasons. However, some upgrading is planned and will make additional water available for diversion, principally in the lower reaches of the Humboldt River.

The demand for about 16,500 acre-feet of water for thermal electric power in the 1980-2000 time frame has been shifted from the water-short Central Lahontan Subregion to the Humboldt Subregion. This use will decrease to 8,000 acre-feet by 2020 when a large nuclear plant in the Central Lahontan Subregion will provide base load power. Water for power in the Humboldt Subregion will be met from ground-water supplies.

Planned water-based recreation needs will be satisfied primarily by construction of three reservoirs on tributaries to the Humboldt River by 1980, and another on the Little Humboldt by 2020. These lakes will also help satisfy fish and wildlife demands. Increased development at existing facilities will satisfy most other fish and wildlife demands.

Table 77 shows the facilities associated with water development. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use.

TABLE 77. FACILITIES REQUIRED TO DEVELOP THE PLAN - HUMBOLDT SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	257	171	105	533
Drainage	1000 acres	6	6	8	20
Waste water treatment	1000 AF.	2	2	2	6

Land Resources Development

The land resources are sufficient to meet projected requirements. Table 78 shows the planned land use changes. The largest increases in use occur for fish and wildlife and outdoor recreation. The fish and wildlife use is principally for big game habitat. Grazing land use will decrease by 739,000 acres; however, production on remaining land will increase by 634,000 AUMs. Some consolidation of the checkerboard pattern of land ownership along the Humboldt River is planned. This will create more manageable units for utilizing the range potential.

TABLE 78. PLANNED LAND USES - HUMBOLDT SUBREGION

Great Basin Region

Principal use[1/]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	335	332	329	345	+ 10
Dry cropland	0	0	0	0	0
Grazing land	15,641	15,477	15,280	14,902	- 739
Timber	0	0	0	0	0
Urban and industrial	21	21	22	23	+ 2
Outdoor recreation	70	172	325	557	+ 487
Wilderness and scenic	35	73	73	73	+ 38
Flood control measures	2	12	39	51	+ 49
Military and related	0	0	0	0	0
Minerals	56	113	166	215	+ 159
Fish and wildlife	613	1,009	1,100	1,192	+ 579
Classified watershed	0	10	20	70	+ 70
Transportation and utilities	140	151	158	162	+ 22
Water control reservoirs	26	34	39	43	+ 17

1/ Multiple uses of land are made in most categories.

Table 79 shows planned irrigated land development. About 20,000 acres of new land will be developed in the final time frame to replace production on land lost to other uses in the urbanized Central Lahontan Subregion. Production on land lost to other uses in the Humboldt Subregion will be replaced by increased yields on remaining land. The most significant crops will continue to be native hay and pasture.

TABLE 79. PLANNED IRRIGATED LAND DEVELOPMENT - HUMBOLDT SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	335	335	332	329	-
Loss to other uses[1/]	-	-3	-3	-4	- 10
New land development[1/]	-	0	0	20	+ 20
Net developed land	335	332	329	345	+ 10
Idle land remaining	3	20	3	3	0
Productive land	332	312	326	342	+ 10

1/ Values are incremental amounts.

The watershed treatment program associated with the plan is shown in Table 80. The treatment on irrigated cropland involves improvement in drainage and water application. The program on forest and rangeland is primarily land treatment measures.

TABLE 80. WATERSHED TREATMENT PROGRAM - HUMBOLDT SUBREGION

Great Basin Region

	1965-1980	1980-2000	2000-2020	1965-2020
			(1,000 acres)	
Irrigated cropland	49	66	59	174
Forest and rangeland	2,680	4,040	2,080	8,800
Total	2,729	4,106	2,139	8,974

Other Resources Development

The flood control plan includes watershed treatment, flood plain management, improved flood forecasting, and structural measures. Flood control storage capacity would increase 513,000 acre-feet. Some of the storage facilities would provide fish and wildlife, and recreation opportunities. Table 81 shows the elements of the flood control plan.

TABLE 81. ELEMENTS OF THE FLOOD CONTROL PLAN - HUMBOLDT SUBREGION

Great Basin Region

Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	237	171	105	513
Levees	miles	2	0	0	2
Channels	miles	10	0	0	10
Watershed treatment 1/	1000 acres	10	11	11	32
Flood plain management	No. areas	0	2	0	2

1/ Included in watershed treatment program.

Summit Lake and its tributaries are the home and spawning grounds of the only known remaining native population of the Lahontan cutthroat trout. These trout have exhibited a higher tolerance to saline water than any other, and are uniquely suited to the waters of Pyramid and Walker Lakes. Development in the Summit Lake watershed should be carefully controlled so that this fishery will not be jeopardized.

Increased agricultural uses of water on the Humboldt River will increase salinities. This saline condition is aggravated by inadequate treatment of present municipal outflows. The plan provides for secondary treatment of sewage effluents. The large projected mineral development will cause scarring of large areas of the landscape and cause erosion and sedimentation problems. These problems will be met by critical area treatment which includes mined area restoration.

Effects of Development to Meet the Plan

The primary effect of the plan is upgrading present irrigation practices to provide part of the production lost to urban expansion in the Central Lahontan Subregion. Ground water will be developed for the increased municipal and industrial uses and new irrigation developments. There may be mining of ground water in some local areas, but generally annual recharge will maintain the supply. The proposed flood control dams will have a favorable effect on fish and wildlife habitat and recreational opportunities. Improved big game habitat areas should enhance hunting.

Costs

A summary of framework plan costs is presented in Table 82. An explanation of the various cost items is given under the regional plan discussion.

Water development costs would be about $102 million by 2020, and OM&R costs would be about $5 million annually.

Total development costs, which include associated development, would be about $270 million by 2020. OM&R costs would be about $18 million annually at the end of this period.

Central Lahontan Subregion

The Central Lahontan Subregion is the second most industrialized area in the Region. Agriculture and mining are also significant. This Subregion contains important urban areas and will experience the most rapid population growth rate in the Region.

Water Resources Development

Planned water uses are shown in Table 83. Withdrawals are expected to increase by 139,000 acre-feet during the 1965-2020 period and depletions by 105,000 acre-feet. The requirements to maintain the terminal lakes are discussed later. About 78,000 acre-feet of the planned withdrawals would be developed from surface water and the remaining 61,000 acre-feet from ground-water supplies. These include salvage and reuse of return flows.

TABLE 82. COMPREHENSIVE FRAMEWORK PLAN COSTS - HUMBOLDT SUBREGION

Great Basin Region

Major function	Water development Instal-lation	Water development OM&R Incr.	Water development OM&R Cum.	Associated development Instal-lation	Associated development OM&R Incr.	Associated development OM&R Cum.	Total development Instal-lation	Total development OM&R Incr.	Total development OM&R Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	300	20		0	0		300	20	
Irrigation & drainage	2,200	20		10,200	700		12,400	720	
Electric power	0	0		5,400	160		5,400	160	
Flood control	8,600	150		0	0		8,600	150	
Outdoor recreation	4,100	370		8,000	630		12,100	1,000	
Fish and wildlife	300	10		2,900	220		3,200	230	
Water quality	19,800	300		0	0		19,800	300	
Land management	4,200	310		12,800	930		17,000	1,240	
Other development	800	480		0	0		800	480	
Total program	40,300	1,660		39,300	2,640		79,600	4,300	
Federal	28,100	1,100		24,300	1,470		52,400	2,570	
Non-Federal	12,200	560		15,000	1,170		27,200	1,730	
1980-2000 Time frame									
Municipal & industrial	1,200	60	80	0	0	0	1,200	60	80
Irrigation & drainage	6,000	40	60	13,500	920	1,620	19,500	960	1,680
Electric power	1,200	60	60	19,000	2,160	2,320	20,200	2,220	2,380
Flood control	17,200	340	490	0	0	0	17,200	340	490
Outdoor recreation	0	0	370	8,900	740	1,370	8,900	740	1,740
Fish and wildlife	0	0	10	2,900	220	440	2,900	220	450
Water quality	300	400	700	0	0	0	300	400	700
Land management	4,700	120	430	14,400	360	1,290	19,100	480	1,720
Other development	700	370	850	0	0	0	700	370	850
Total program	31,300	1,390	3,050	58,700	4,400	7,040	90,000	5,790	10,090
Federal	21,100	630	1,730	25,600	890	2,360	46,700	1,520	4,090
Non-Federal	10,200	760	1,320	33,100	3,510	4,680	43,300	4,270	6,000
2000-2020 Time frame									
Municipal & industrial	1,500	70	150	0	0	0	1,500	70	150
Irrigation & drainage	15,400	590	650	12,200	840	2,460	27,600	1,430	3,110
Electric power	0	0	60	37,100	3,890	6,210	37,100	3,890	6,270
Flood control	9,800	140	630	0	0	0	9,800	140	630
Outdoor recreation	100	0	370	11,500	930	2,300	11,600	930	2,670
Fish and wildlife	100	10	20	2,900	220	660	3,000	230	680
Water quality	400	700	1,400	0	0	0	400	700	1,400
Land management	2,100	140	570	6,600	420	1,710	8,700	560	2,280
Other development	600	370	1,220	0	0	0	600	370	1,220
Total program	30,000	2,020	5,070	70,300	6,300	13,340	100,300	8,320	18,410
Federal	17,200	470	2,200	20,000	1,140	3,500	37,200	1,610	5,700
Non-Federal	12,800	1,550	2,870	50,300	5,160	9,840	63,100	6,710	12,710
1965-2020 Time frame									
Municipal & industrial	3,000	150		0	0		3,000	150	
Irrigation & drainage	23,600	650		35,900	2,460		59,500	3,110	
Electric power	1,200	60		61,500	6,210		62,700	6,270	
Flood control	35,600	630		0	0		35,600	630	
Outdoor recreation	4,200	370		28,400	2,300		32,600	2,670	
Fish and wildlife	400	20		8,700	660		9,100	680	
Water quality	20,500	1,400		0	0		20,500	1,400	
Land management	11,000	570		33,800	1,710		44,800	2,280	
Other development	2,100	1,220		0	0		2,100	1,220	
Total program	101,600	5,070		168,300	13,340		269,900	18,410	
Federal	66,400	2,200		69,900	3,500		136,300	5,700	
Non-Federal	35,200	2,870		98,400	9,840		133,600	12,710	

The largest increase in water use will occur for municipal and industrial purposes. High quality supplies would be met from surface water, ground water, and conversion and exchange of irrigation water. For the purposes of the plan, per capita use in the Reno-Sparks area was reduced by 1980 and held constant through the remaining time frames. The alternative projections, based on employment in the manufacturing sector rather than on total gross output, was used to determine the self-supplied industrial rates for the Subregion. These adjustments decrease withdrawals 54,000 acre-feet and depletions 32,000 acre-feet by 2020.

TABLE 83. PLANNED WATER USES - CENTRAL LAHONTAN SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Withdrawals					
Municipal & industrial 1/	54	75	126	196	+ 142
Thermal electric power 1/	1	7	12	37	+ 36
Recreation	1	2	4	6	+ 5
Minerals	6	18	23	27	+ 21
Irrigation	1,075	1,061	1,055	1,006	- 69
Fish and wildlife	271	273	273	275	+ 4
Total	1,408	1,436	1,493	1,547	+ 139
Depletions					
Municipal & industrial 1/	20	28	48	74	+ 54
Thermal electric power 1/	1	7	12	37	+ 36
Recreation	1	1	1	2	+ 1
Minerals	2	8	11	13	+ 11
Irrigation	406	408	423	424	+ 18
Nonirrigated wet meadows	120	115	105	95	- 25
Managed fish & wildlife	259	261	261	263	+ 4
Unmanaged fish & wildlife & associated wetland	46	46	46	46	0
Reservoir evaporation	63	68	69	69	+ 6
Total	918	942	976	1,023	+ 105

Note: Evaporation from Pyramid and Walker Lakes is not included.
1/ Values adjusted in framework plan formulation.

Table 84 shows planned irrigation water use. Supplemental water supplies to meet increased production on irrigated land will be met through increased efficiency.

TABLE 84. PLANNED IRRIGATION WATER USE - CENTRAL LAHONTAN SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Diversions					
Presently developed cropland[1/]	1,075	1,061	1,055	1,006	- 69
New cropland	-	0	0	0	0
Total diversions	1,075	1,061	1,055	1,006	- 69
Depletions					
Presently developed cropland[1/]	406	408	423	424	+ 18
New cropland	-	0	0	0	0
Total depletions	406	408	423	424	+ 18

1/ Includes water for idle land restored to production.

Table 85 shows the facilities associated with water development. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use. Surface water storage facilities do not include reservoirs in California that regulate water used in Nevada.

TABLE 85. FACILITIES REQUIRED TO DEVELOP THE PLAN - CENTRAL LAHONTAN SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage	1000 AF.	166	79	11	256
Drainage	1000 acres	6	10	6	22
Water treatment	1000 AF.	9	31	40	80
Waste water treatment	1000 AF.	15	35	50	100

Table 86 shows land uses to meet the plan. The most important change is the increase in urban and industrial land use, although both fish and wildlife, and wilderness and scenic uses require the largest additional acreages. Other major changes include increases for mineral production and outdoor recreation, and decreases in timber and grazing land. Production on the remaining grazing land will increase about 70,000 AUMs.

TABLE 86. PLANNED LAND USES - CENTRAL LAHONTAN SUBREGION

Great Basin Region

Principal use[1/]	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	262	254	242	228	- 34
Dry cropland	0	0	0	0	0
Grazing land	3,668	3,623	3,566	3,525	- 143
Timber	80	0	0	0	- 80
Urban and industrial	125	141	168	200	+ 75
Outdoor recreation	10	46	71	101	+ 91
Wilderness and scenic	0	232	232	232	+ 232
Flood control measures	3	7	15	17	+ 14
Military and related	137	137	137	137	0
Minerals	25	57	81	105	+ 80
Fish and wildlife	230	370	404	437	+ 207
Classified watershed	97	101	115	118	+ 21
Transportation and utilities	91	100	108	113	+ 22
Water control reservoirs	68	71	76	77	+ 9

1/ Multiple uses of land are made in most categories.

Table 87 shows the planned irrigated land development. About 7,000 acres of idle land is restored to production to partially replace 34,000 acres of irrigated land converted to urban and industrial expansion. The remaining required production is shifted to irrigated lands in the Humboldt and Tonopah Subregions.

TABLE 87. PLANNED IRRIGATED LAND DEVELOPMENT - CENTRAL LAHONTAN SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	262	262	254	242	-
Loss to other uses[1/]	-	-8	-12	-14	- 34
New land development	-	-	-	-	0
Net developed land	262	254	242	228	- 34
Idle land remaining	12	14	7	5	+ 7[2/]
Productive land	250	240	235	223	- 27

1/ Values are incremental amounts.
2/ Idle land restored to production.

The watershed treatment program associated with the plan is shown in Table 88. The treatment on irrigated cropland involves improvement in drainage and water application. The program on forest and rangeland is primarily land treatment measures.

TABLE 88. WATERSHED TREATMENT PROGRAM - CENTRAL LAHONTAN SUBREGION

				Great Basin Region
	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	16	30	35	81
Forest and rangeland	360	330	280	970
Total	376	360	315	1,051

Other Resources Development

The flood control plan includes 176,000 acre-feet of reservoir storage, principally in multiple-use structures. A large increase in the flood forecasting program is included in the plan. Over 70 percent of the levees planned in the Region are located in this Subregion. The flood control plan elements are shown in Table 89.

TABLE 89. ELEMENTS OF THE FLOOD CONTROL PLAN - CENTRAL LAHONTAN SUBREGION

					Great Basin Region
Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	101	70	5	176
Levees	miles	0	36	34	70
Channels	miles	7	36	17	60
Watershed treatment 1/	1000 acres	27	30	29	86
Flood plain management	No. areas	1	2	3	6

1/ Also included in watershed management program.

There are sufficient land areas to satisfy all planned recreation uses through substitution of recreation Class III lands for other classes. Pinyon, juniper, or desert sage lands, although not generally classed wilderness areas, will meet this demand. Planned water-based recreation includes additional facilities and improved access to existing water developments.

Better management of fish and wildlife resources will be implemented. Habitat will be increased, primarily for big game. Existing fisheries and planned water developments will satisfy fishing demands through 2020.

The thermal plant projected by the electric power appendix to be built in this Subregion in the second time frame has been shifted to the Humboldt Subregion, where the demand for cooling water can be met. Some geothermal use for power production is expected in the last time frame, but the major increase in energy production will be the nuclear plant to be built in the Carson Sink area. A pumped storage plant is planned for the eastern slope of the Sierra Nevada. Imports will be discontinued by 1980.

Advanced treatment of municipal and industrial waste water in the Carson City and Reno-Sparks population centers is planned by 2020. In the Lake Tahoe area, all solid wastes and sewage effluents will be transported from the basin. These effluents will receive advanced treatment prior to export.

Effects of Development to Meet the Plan

The population is expected to increase 250 percent by 2020. Development planning, including land use zoning, will be necessary if problems associated with large cities are to be prevented.

The major effect of the plan is the additional burden placed on the limited water supply. To meet the plan, per capita use of municipal water in the Reno-Sparks area would be reduced and agricultural production on land lost to urbanization would be shifted to adjacent subregions. Development of the Nevada portion of the Lake Tahoe area will be constrained by the limited withdrawals that can be made from the lake under the terms of a pending compact. The planned urban, mineral, and electric power developments in Mason Valley may deplete the available water supply in the Walker River Drainage.

Increased water uses in the Subregion would decrease inflows to the terminal lakes and cause further long-term declines in the lake levels. However, climatic variations will continue to cause greater fluctuations in lake levels than upstream development. Increased water use will have adverse effects on recreation, fish, and wildlife.

Costs

A summary of framework plan costs is presented in Table 90. An explanation of the various cost items is given under the regional plan discussion.

TABLE 90. COMPREHENSIVE FRAMEWORK PLAN COSTS - CENTRAL LAHONTAN SUBREGION

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal-lation	OM&R		Instal-lation	OM&R		Instal-lation	OM&R	
		Incr.	Cum.		Incr.	Cum.		Incr.	Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	20,500	480		0	0		20,500	480	
Irrigation & drainage	6,200	40		6,900	410		13,100	450	
Electric power	500	20		79,400	9,560		79,900	9,580	
Flood control	11,500	70		0	0		11,500	70	
Outdoor recreation	4,600	250		59,500	4,560		64,100	4,810	
Fish and wildlife	2,500	10		5,300	390		7,800	400	
Water quality	16,600	3,110		0	0		16,600	3,110	
Land management	1,800	110		5,700	340		7,500	450	
Other development	1,700	480		0	0		1,700	480	
Total program	65,900	4,570		156,800	15,260		222,700	19,830	
Federal	38,800	820		9,600	660		48,400	1,480	
Non-Federal	27,100	3,750		147,200	14,600		174,300	18,350	
1980-2000 Time frame									
Municipal & industrial	18,000	1,120	1,600	0	0	0	18,000	1,120	1,600
Irrigation & drainage	8,200	50	90	12,900	760	1,170	21,100	810	1,260
Electric power	143,700	3,260	3,280	344,300	36,160	45,720	488,000	39,420	49,000
Flood control	70,400	250	320	0	0	0	70,400	250	320
Outdoor recreation	10,200	110	360	69,600	6,590	11,150	79,800	6,700	11,510
Fish and wildlife	1,600	10	20	5,300	390	780	6,900	400	800
Water quality	16,300	4,920	8,030	0	0	0	16,300	4,920	8,030
Land management	1,400	40	150	4,600	120	460	6,000	160	610
Other development	700	310	790	0	0	0	700	310	790
Total program	270,500	10,070	14,640	436,700	44,020	59,280	707,200	54,090	73,920
Federal	80,100	910	1,730	12,400	520	1,180	92,500	1,430	2,910
Non-Federal	190,400	9,160	12,910	424,300	43,500	58,100	614,700	52,660	71,010
2000-2020 Time frame									
Municipal & industrial	23,500	1,470	3,070	0	0	0	23,500	1,470	3,070
Irrigation & drainage	7,600	50	140	14,900	910	2,080	22,500	960	2,220
Electric power	110,100	2,420	5,700	1,124,500	51,610	97,330	1,234,600	54,030	103,030
Flood control	8,800	80	400	0	0	0	8,800	80	400
Outdoor recreation	0	0	360	101,600	9,830	20,980	101,600	9,830	21,340
Fish and wildlife	0	0	20	9,000	680	1,460	9,000	680	1,480
Water quality	20,800	6,720	14,750	0	0	0	20,800	6,720	14,750
Land management	1,000	40	190	3,500	120	580	4,500	160	770
Other development	600	310	1,100	0	0	0	600	310	1,100
Total program	172,400	11,090	25,730	1,253,500	63,150	122,430	1,425,900	74,240	148,160
Federal	20,900	840	2,570	12,000	670	1,850	32,900	1,510	4,420
Non-Federal	151,500	10,250	23,160	1,241,500	62,480	120,580	1,393,000	72,730	143,740
1965-2020 Time frame									
Municipal & industrial	62,000	3,070		0	0		62,000	3,070	
Irrigation & drainage	22,000	140		34,700	2,080		56,700	2,220	
Electric power	254,300	5,700		1,548,200	97,330		1,802,500	103,030	
Flood control	90,700	400		0	0		90,700	400	
Outdoor recreation	14,800	360		230,700	20,980		245,500	21,340	
Fish and wildlife	4,100	20		19,600	1,460		23,700	1,480	
Water quality	53,700	14,750		0	0		53,700	14,750	
Land management	4,200	190		13,800	580		18,000	770	
Other development	3,000	1,100		0	0		3,000	1,100	
Total program	508,800	25,730		1,847,000	122,430		2,355,800	148,160	
Federal	139,800	2,570		34,000	1,850		173,800	4,420	
Non-Federal	369,000	23,160		1,813,000	120,580		2,182,000	143,740	

Water development costs would be about $509 million by 2020, and OM&R costs would be about $26 million annually.

Total development costs, which include associated development, would be about $2,336 million by 2020. OM&R costs would be about $148 million annually at the end of this period.

Alternative Considerations for Pyramid and Walker Lakes

The following paragraphs briefly describe the impacts of maintaining Pyramid and Walker Lakes. The plan to meet the OBE-ERS projections does not include water to maintain these lakes. The importance of these lakes for recreation, fish and wildlife, and other uses including esthetics, is recognized. Inflow into these lakes under present conditions is insufficient to maintain them at their present levels. Planned economic activity requires additional diversions from streams contributing inflow to the lakes. This will accelerate the historic rate of decline.

The impact of maintaining the lakes is analyzed as an alternative to meeting the water needs implicit in the OBE-ERS projections. The Great Basin Region Input-Output model was used to estimate the economic impact of maintaining the lakes. The results should be interpreted only as a theoretical indication of the relative magnitude of the effects which changes in water allocation may cause. Data were not available to analyze the benefits of maintaining these lakes, their contribution to gross regional product, or their recreational and esthetic values.

The first alternative analyzes the effects of maintaining the 1965 inflows to the lakes, and the 1965 level of depletion from the Truckee and Walker Rivers. The 1965 flow of these rivers was taken to be the 1931-1960 average, modified for the 1965 level of development. The Truckee River flow was further modified to reflect recent changes such as the Rules and Regulations - Truckee and Carson River Basins, and evaporation from Stampede reservoir. Reduced municipal and industrial water requirements shown in the subregional plan were also used.

The effect at the 2020 level of development for the first alternative is shown in the tabulation on page 116. These effects include impacts on total gross output, employment, and population, and are designated as P-1 for Pyramid Lake and W-1 for Walker Lake.

The second alternative maintains the 1965 lake levels. This analysis has two stages of effects. The first is a result of the immediate reduction in upstream water use to provide sufficient inflow to maintain the 1965 lake levels. The second is the accumulative effect by 2020 of maintaining this reduced use.

To analyze the first stage, the adjustment to reduce 1965 uses was made in direct proportion to those uses. For example, a use which consumed 20 percent of the total depletion in 1965 would bear 20 percent of the reduction necessary to maintain the 1965 lake level. The theoretical impact, of this stage, in 1965 of maintaining Walker Lake at the 1965 level is shown as W-2. The impact, of this first stage, at the 1965 level of development on the Truckee River system was analyzed in two ways. The first, designated P-2 in the tabulation, is based on 1965 per capita use rates, from a reduced supply, and reflects an immediate reduction in population. The second, P-3, reflects the decreased household per capita use rate, indicated in the Subregional plan, and increased use of ground water.

The second stage, W-3 and P-4, shows the economic effects of maintaining the 1965 lake levels in the year 2020. The values shown are reductions for the 2020 level of development.

The following tabulation shows the annual reduction in OBE-ERS levels of development.

Alternatives & time frames	Total gross output	Employment	Population
	(1,000 dollars)	(man-years)	
Walker Lake			
W-1 (2020)	266,000	3,000	7,000
W-2 (1965)	6,300	400	950
W-3 (2020)	286,000	3,300	8,300
Pyramid Lake			
P-1 (2020)	3,295,000	62,300	156,000
P-2 (1965)	294,000	23,700	56,800
P-3 (1965)	106,000	6,100	14,700
P-4 (2020)	5,898,000	106,000	266,000

A reconnaissance investigation, made as a part of the Comprehensive Framework Study, has considered the importation of desalted ocean water, by exchange, to supply these lakes. Costs, in 1970 dollars, are in the magnitude of $300 per acre-foot.

Weather modification is another possibility being studied. Although present knowledge in this area is limited, and legal questions uncertain, costs of $1.00 to $2.00 per acre-foot may be possible. A pilot program is presently being conducted under the direction of the Bureau of Reclamation.

The position of the Secretary of the Interior, with regard to the preservation of Pyramid and Walker Lakes, is that the Department is committed to developing a method of preserving the lakes. This fact is demonstrated by the Pyramid Lake Task Force and its objectives and by other activities of this Department.1/

The Pyramid Lake Task Force is making an intensive study of Truckee River and Pyramid Lake problems. Several areas have been selected for study as possible ways of augmenting present supplies. Some reports have been published and the others are scheduled to be finished before the Task Force makes its report in December 1971.

An economic analysis of alternative water uses is presently being conducted by the Economic Subcommittee of the Task Force. As a part of the study, comparisons will be made between agricultural and recreational benefits.

The Betterment Studies Subcommittee has made several recommendations of ways to augment the water supply to Pyramid Lake. One with possibly the greatest impact is suppression of evaporation from the snowpack. No cost figures are available, but a pilot study has been proposed. They are also making an improvement study in the Fallon area.

The Ground Water Subcommittee has recently published a report relative to mining ground water in nearby valleys. Their preliminary estimate shows a cost of about $100 million to maintain Pyramid Lake for 30 years. By that time, the nearby ground-water basins would be essentially depleted. The costs for maintaining Walker Lake by similar development may be about $40 million. Other Task Force studies concerning economics and water rights have not yet been published.

Tonopah Subregion

The Tonopah Subregion economy is predominantly mineral oriented. Agriculture is also important, and these two are expected to remain predominant through 2020. This Subregion is the second highest producer of minerals and contains nearly one-third of the grazing land. A large nuclear testing facility, occupying 60 percent of the military land of the Region, provided a substantial share of the subregional economy in 1965. The Subregion depends primarily on ground-water

1/ Letters of May 17, 1971 and July 22, 1971 from Harrison Loesch, Assistant Secretary of the Interior, to Mr. B. J. Vasey, cochairman of Great Basin Region SFIC, and letter of May 17, 1971 from Harrison Loesch Assistant Secretary of the Interior, to Mr. Robert D. Stitser, Attorney at Law, Reno, Nevada.

supplies for most uses since it has no major rivers. Although the population is projected to double by 2020, the Subregion will still be the least densely populated.

Water Resources Development

Planned water withdrawals will increase 225,000 acre-feet by 2020 and depletions by 135,000 acre-feet. These are shown in Table 91. The additional water supply will be developed primarily from ground water. Irrigation will continue to be the major use although its proportionate share of total depletions will remain about 65 percent. Irrigation water diversions will increase by 133,000 acre-feet and depletions by 70,000 acre-feet. The longer growing season in the southern part of the Subregion may attract most of the planned new cropland. Water supplies for this additional acreage would come from ground-water development. The planned irrigation water use is shown in Table 92.

TABLE 91. PLANNED WATER USES - TONOPAH SUBREGION

Great Basin Region

Type of use	1965	1980	2000	2020	Change 1965-2020
			(1,000 acre-feet)		
Withdrawals					
Municipal & industrial	13	18	27	42	+ 29
Thermal electric power	1	1	1	1	0
Recreation	1	1	1	2	+ 1
Minerals	14	29	36	52	+ 38
Irrigation	419	453	506	552	+ 133
Fish and wildlife	61	85	85	85	+ 24
Total	509	587	656	734	+ 225
Depletions					
Municipal & industrial	3	4	7	13	+ 10
Thermal electric power	1	1	1	1	0
Recreation	1	1	1	1	0
Minerals	10	20	25	41	+ 31
Irrigation	234	250	278	304	+ 70
Nonirrigated wet meadows	40	40	40	40	0
Managed fish & wildlife	61	85	85	85	+ 24
Reservoir evaporation	1	1	1	1	0
Total	351	402	438	486	+ 135

TABLE 92. PLANNED IRRIGATION WATER USE - TONOPAH SUBREGION

Great Basin Region

	1965	1980	2000	2020	1965-2020
		(1,000 acre-feet)			
Diversions					
Presently developed cropland 1/	419	449	489	528	+ 109
New cropland	-	4	17	24	+ 24
Total diversions	419	453	506	552	+ 133
Depletions					
Presently developed cropland 1/	234	248	270	293	+ 59
New cropland	-	2	8	11	+ 11
Total depletions	234	250	278	304	+ 70

1/ Includes water for idle land restored to production.

Water development depends primarily on ground-water resources, some flood detention, and development of secondary streams. Secondary stream development is mostly short term regulation storage. Table 93 shows the facilities associated with water resource development. These facilities include developing the supply, conveying it to the point of use, and treatment. They do not include those associated directly with water use.

TABLE 93. FACILITIES REQUIRED TO DEVELOP THE PLAN - TONOPAH SUBREGION

Great Basin Region

Facility	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Surface water storage 1/	1000 AF.	37	50	43	130
Ground-water development	1000 AF.	-	-	-	205
Drainage	1000 acres	1	1	1	3
Water treatment	1000 AF.	1	1	2	4
Waste water treatment	1000 AF.	3	4	8	15

1/ Specific flood control storage only.

Water requirements will be supplied by ground-water development which includes extensions of existing systems to more remote supplies. The mining industry now uses both surface and ground water, but future expansion of this use is planned to come from ground water.

Land Resources Development

An important use of land is for military and related purposes. This land use is not planned to increase, but is significant since generally it is not available for other purposes.

The major planned land use increases are fish and wildlife, outdoor recreation, wilderness, and scenic. Grazing land use will decrease by 601,000 acres, although increased production of 215,000 AUMs is planned on the remaining grazing land. The planned land use changes are shown in Table 94.

TABLE 94. PLANNED LAND USE REQUIREMENTS - TONOPAH SUBREGION

Great Basin Region

Principal use 1/	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Irrigated cropland	190	190	193	194	+ 4
Dry cropland	0	0	0	0	0
Grazing	20,232	19,948	19,817	19,631	- 601
Timber	29	29	29	28	- 1
Urban and industrial	18	18	20	22	+ 4
Outdoor recreation	141	392	495	657	+ 516
Wilderness and scenic	34	420	420	420	+ 386
Flood control measures	1	8	17	25	+ 24
Military and related	2,964	2,964	2,964	2,964	0
Minerals	133	235	272	320	+ 187
Fish and wildlife	815	1,311	1,430	1,549	+ 734
Classified watershed	0	26	43	60	+ 60
Transportation and utilities	77	86	93	97	+ 20
Water control reservoirs	2	3	5	7	+ 5

1/ Multiple uses of land are made in most categories.

About 7,000 acres of new irrigated cropland and 11,000 acres of idle land will be brought into production by 2020. These are shown in Table 95. This will replace part of the production lost in the Central Lahontan Subregion to urban and industrial expansion. The major crops would continue to be forage crops, alfalfa and feed grains, with increased production of alfalfa seed.

TABLE 95. PLANNED IRRIGATED LAND DEVELOPMENT - TONOPAH SUBREGION

Great Basin Region

	1965	1980	2000	2020	Change 1965-2020
			(1,000 acres)		
Previously developed land	190	190	190	193	-
Loss to other uses1/	-	-1	-1	-1	- 3
New land development1/	-	1	4	2	+ 7
Net developed land	190	190	193	194	+ 4
Idle land remaining	15	12	8	4	+112/
Productive land	175	178	185	190	+15

1/ Values are incremental amounts.
2/ Idle land restored to production.

The watershed treatment program associated with the plan is shown in Table 96. The treatment on irrigated cropland involves improvement in drainage and water application while the program on forest and rangeland is primarily reseeding and protection of frail lands.

TABLE 96. WATERSHED TREATMENT PROGRAM - TONOPAH SUBREGION

Great Basin Region

Land resource	1965-1980	1980-2000	2000-2020	1965-2020
		(1,000 acres)		
Irrigated cropland	34	51	28	113
Forest and rangeland	3,600	4,580	2,760	10,940
Total	3,634	4,631	2,788	11,053

Other Resources Development

The flood control plan includes 130,000 acre-feet of reservoir storage, principally in small structures, and improved flood forecasting. The flood control plan elements are shown in Table 97.

TABLE 97. ELEMENTS OF THE FLOOD CONTROL PLAN - TONOPAH SUBREGION

		Great Basin Region			
Elements	Unit	1965-1980	1980-2000	2000-2020	1965-2020
Reservoir capacity	1000 AF.	37	50	43	130
Channels	miles	0	2	2	4
Watershed treatment1/	1000 acres	23	24	24	71
Flood plain management	No. areas	2	0	0	2

1/ Also included in watershed treatment program.

There are sufficient land areas to satisfy all planned recreation through substitution of recreation Class III lands for other classes. The Subregion contains vast desert areas which can serve as wilderness, although it is not generally considered in this classification. The disproportionately large water-based recreation demand can be met only by substitution of land-based recreation activity.

Additional waterfowl habitat development is planned in the northern part of the Subregion during the first time frame. Additional facilities and planned improvement of big game habitat will satisfy local hunting demands, but not those from population centers outside the Region.

No new power plants are planned. The intertie now being constructed across Nevada and western Utah will provide power for mining, agriculture, and other uses in the northern part of the Subregion.

Some municipal water supplies will be treated, principally to remove objectionable trace elements. Secondary treatment of effluent from all municipal and most industrial sources is planned.

Effects of Development to Meet the Plan.

A major effect of the plan will be development of the ground-water resources. Development may be constrained by very low precipitation and small annual recharge. In the Ely-McGill area mineral developments may be constrained by the limited water supply. Mining and exporting ground water from one of the southern valleys of this Subregion has been proposed to supply municipal and industrial water for the rapidly growing Las Vegas area. This would restrict local development for irrigation. Another effect of the plan is the major changes in land use. About 10 percent of the land area will be utilized for recreational activities.

Costs

A summary of framework plan costs is presented in Table 98. An explanation of the various cost items is given under the regional plan discussion.

Water development costs would be about $56 million by 2020 and OM&R costs would be about $4 million annually.

Total development costs, which include associated development, would be about $216 million by 2020. OM&R costs would be about $15 million annually at the end of this period.

Legal and Institutional Constraints

The development of a framework plan necessitates consideration of legal and institutional constraints. The water laws of the States in the Great Basin Region are based on the appropriation doctrine. They do not recognize maintaining streamflows or lake and reservoir levels as a beneficial use.

Existing statutes regulating mining of ground water must be clarified. Planned mining of ground water in some areas is necessary to meet projected needs.

There are no effective regulations which prevent construction in flood plain or flood prone areas. Regulation of development in flood plain areas is necessary to reduce flood damages.

The States feel it is important for the Federal government to quantify its water demands for Federal lands. This problem, coupled with the lack of a legal requirement for the Federal government to comply with state water laws, causes uncertainty in state water planning. Federal legislation establishing national land use policies would also aid in state planning.

Pollution standards for air and water need further research and modification. In many cases, existing standards are too low to adequately protect air and water quality. Besides the need to revise existing laws, there is a need for proper enforcement.

The intrastate transfer of water presently leaves the area from which water is taken without legal protection. Protection of areas of origin in possible future transfers of water is necessary.

TABLE 98. COMPREHENSIVE FRAMEWORK PLAN COSTS - TONOPAH SUBREGION

Great Basin Region

Major function	Water development			Associated development			Total development		
	Instal-lation	OM&R		Instal-lation	OM&R		Instal-lation	OM&R	
		Incr.	Cum.		Incr.	Cum.		Incr.	Cum.
	(Thousands of 1965 constant dollars)								
1965-1980 Time frame									
Municipal & industrial	800	40		0	0		800	40	
Irrigation & drainage	800	30		4,800	360		5,600	390	
Electric power	0	0		5,400	160		5,400	160	
Flood control	5,600	70		0	0		5,600	70	
Outdoor recreation	100	10		24,600	1,970		24,700	1,980	
Fish and wildlife	200	10		1,500	110		1,700	120	
Water quality	600	130		0	0		600	130	
Land management	5,200	450		15,700	1,360		20,900	1,810	
Other development	2,100	440		0	0		2,100	440	
Total program	15,400	1,180		52,000	3,960		67,400	5,140	
Federal	11,800	720		39,900	2,990		51,700	3,710	
Non-Federal	3,600	460		12,100	970		15,700	1,430	
1980-2000 Time frame									
Municipal & industrial	2,800	180	220	0	0	0	2,800	180	220
Irrigation & drainage	3,500	120	150	7,100	540	900	10,600	660	1,050
Electric power	0	0	0	0	0	160	0	0	160
Flood control	9,200	90	160	0	0	0	9,200	90	160
Outdoor recreation	0	0	10	28,800	2,270	4,240	28,800	2,270	4,250
Fish and wildlife	0	0	10	1,500	110	220	1,500	110	230
Water quality	700	270	400	0	0	0	700	270	400
Land management	4,400	140	590	13,300	400	1,760	17,700	540	2,350
Other development	1,000	280	720	0	0	0	1,000	280	720
Total program	21,600	1,080	2,260	50,700	3,320	7,280	72,300	4,400	9,540
Federal	13,200	320	1,040	42,900	2,440	5,430	56,100	2,760	6,470
Non-Federal	8,400	760	1,220	7,800	880	1,850	16,200	1,640	3,070
2000-2020 Time frame									
Municipal & industrial	2,700	130	350	0	0	0	2,700	130	350
Irrigation & drainage	3,400	70	220	3,800	280	1,180	7,200	350	1,400
Electric power	0	0	0	0	0	160	0	0	160
Flood control	7,600	80	240	0	0	0	7,600	80	240
Outdoor recreation	0	0	10	45,500	3,550	7,790	45,500	3,550	7,800
Fish and wildlife	0	0	10	1,500	110	330	1,500	110	340
Water quality	1,000	590	990	0	0	0	1,000	590	990
Land management	2,100	150	740	6,500	440	2,200	8,600	590	2,940
Other development	2,200	350	1,070	0	0	0	2,200	350	1,070
Total program	19,000	1,370	3,630	57,300	4,380	11,660	76,300	5,750	15,290
Federal	10,100	370	1,410	52,200	3,760	9,190	62,300	4,130	10,600
Non-Federal	8,900	1,000	2,220	5,100	620	2,470	14,000	1,620	4,690
1965-2020 Time frame									
Municipal & industrial	6,300	350		0	0		6,300	350	
Irrigation & drainage	7,700	220		15,700	1,180		23,400	1,400	
Electric power	0	0		5,400	160		5,400	160	
Flood control	22,400	240		0	0		22,400	240	
Outdoor recreation	100	10		98,900	7,790		99,000	7,800	
Fish and wildlife	200	10		4,500	330		4,700	340	
Water quality	2,300	990		0	0		2,300	990	
Land management	11,700	740		35,500	2,200		47,200	2,940	
Other development	5,300	1,070		0	0		5,300	1,070	
Total program	56,000	3,630		160,000	11,660		216,000	15,290	
Federal	35,100	1,410		135,000	9,190		170,100	10,600	
Non-Federal	20,900	2,220		25,000	2,470		45,900	4,690	

Status of State Water Plans

Formulation of the Idaho State Water Plan entails a threefold program of study to evaluate the water and land resources, determine present and future water and land needs, and formulate plans for the orderly and optimum development of these resources to meet future needs. Basic data and information on the water and related land resources are being provided by a series of studies. The data and information from these studies, in conjunction with that provided by comprehensive framework studies, will serve as the basis for formulation of the plan. The Bear River Basin investigation, joint Federal-State Wild River studies, Western United States Water Plan study, and the Idaho Water Resource staff analysis of particular projects, will also provide detailed input to the plan. This plan, which is being prepared by the Idaho Water Resource Board, is scheduled to be completed in the late 1970's.

The State of Nevada, Division of Water Resources, is now preparing a State Water Plan under the direction of the State Engineer. Work on the plan has been funded since July 1, 1969. Some of the basic data is being provided by comprehensive framework studies. Private firms and consultants, Federal, and State agencies will provide data to supplement work done by the Division planning staff. At the present time, the planning effort is in the final stages of completing resource availability and use inventories. Projection of needs in areas of potential development is underway and plan formulation will follow. The plan is scheduled for completion by June 30, 1973.

Preparation of Utah's water plan is under the direction of the Division of Water Resources. Work of the planning staff is being augmented by Federal and State agencies. A report on water resource development and management goals and objectives has been prepared. The water resources inventory is nearly complete. Present water uses in each of the ten hydrologic areas have been determined. Resource needs are based on State population and economic projections. The comprehensive framework studies, in most instances, have been consistent with State data. Four alternative resource development plans have been formulated. These plans are discussed in a report submitted to the 1971 Legislature. After a two-year period of in-depth study a final plan will be prepared.

In July of 1967, Wyoming initiated its water planning program under the direction of the State Engineer. Wyoming is utilizing a basin-by-basin approach with an inventory stage followed by an analysis of alternate ways of development. The planning staff will utilize programs of State, Federal and private entities to provide additional information for formulation of a State Water Plan. The plan is tentatively scheduled for completion in 1972.

PART VI

ALTERNATIVES TO THE FRAMEWORK PLAN

The plan presented in Part V is oriented toward meeting the regional OBE-ERS allocations of national needs. Several alternative means of satisfying these demands are discussed below under the heading, "Alternative Means of Meeting OBE-ERS Requirements." The subsequent discussion, "Alternative Levels of Development", is directed toward possible deviations from the OBE-ERS projections. These deviations should be considered to the extent they may better utilize the remaining water, land, and other resources.

The regional input-output model was developed primarily for the purpose of comparing alternative levels of output with the OBE-ERS projections. Forty sectors were identified as components of the model so that alternative levels of development within any of the defined sectors could be compared to the OBE-ERS level. Direct and indirect coefficients were determined for each sector. Development of these coefficients permits analysis of changes in physical inputs by sector. Changing one sector at a time permits a relatively accurate evaluation of the effects on the Region's economy. The model was used to evaluate alternatives only to a limited extent.

Alternative Means of Meeting OBE-ERS Requirements

Crop Yield Increases

Based on the 2020 yields, the Region needs an additional 65,000 acres to produce the required food and fiber. If 2020 yields are only 75 percent of those projected, total harvested area would increase by 600,000 acres and water depletions by about 1.0 MAF. Greater investment in land and machinery would be needed because of the increased acreage, and employment would probably increase. Conversely, if 2020 yields are 125 percent of those projected, 300,000 fewer harvested acres and about 0.5 MAF less water would be required.

Change in Water Rights

Projected agricultural production was based on the assumption that water right constraints would result in the continuation of relatively low productivity on marginal lands. The estimated acreage in this category would be 695,000 acres in 2020. An alternative to change water laws and permit transfer of the available water to more productive land, or provide drainage and related works of improvement, would increase the productivity of land and water. With either of these changes, agricultural requirements would be produced on fewer acres and with less water.

Irrigated Land Development

Present water laws preclude or limit the mining of ground water and thus restrict the utilization of this water resource, particularly in the desert valley areas. Since there are large blocks of irrigable lands in many of these valleys where ground water is also available, changes in water laws could allow development of these areas. Such development could be regulated to allow drawdown of the usable ground-water reservoir over a development and productive period sufficient to make the development economically sound.

Irrigated Land Conversion

Under the plan, urban and industrial expansion was assumed to take place mainly on irrigated land adjacent to existing communities. This resulted in the need to identify 239,000 acres of new irrigated land in more remote locations. Considerable cost is involved in developing new land and its associated water supply. To reduce such costs, inducement is needed to establish urban and industrial expansion on nonirrigated lands. In the Great Salt Lake Subregion the effect of reduced irrigation conversion would decrease the water supply converted from irrigation to municipal and industrial use. This would require additional imports or desalting of brackish waters to meet the municipal and industrial demands.

Increased Use of Range Forage

The projection of range forage use is considerably below the estimated potential. Alternative levels of development of the range resource should be evaluated. Increased range forage could replace irrigated pasture to some extent or be used more fully in conjunction with irrigated pasture.

Environmental Considerations

The National Environmental Policy Act of 1969 was adopted on a nationwide basis to safeguard ecological and esthetic values and minimize damage to the environment.

In many respects the plan includes features that improve environmental conditions which exist today. The plan also identifies other future problems requiring consideration. As detailed studies are undertaken, many changes will be necessary to make the plan more compatible with conservation and enhancement of the environment. However, with present knowledge and the development of new ideas and methods, it is anticipated the general concept of the plan can be carried out, with alternatives adopted as necessary, to minimize adverse impacts.

Alternative Levels of Development

Additional study of alternative levels of development should be made prior to implementation of the plan. Studies have been made and more are planned, primarily by the States, to evaluate the economic impacts associated with various potential water uses. The States are anxious to use the remaining water supply in a way which will give greatest economic benefits consistent with environmental considerations and the overall well-being of the people. Such studies could result in the need to shift some of the national allocation among regions. Alternatives relating to the three main terminal lakes are described in the respective subregional plans. Some of the more prominent areas where projected activities could be modified are discussed in the following paragraphs.

Great Salt Lake Mineral Development

Expansion of major proportions has occurred in the chemicals and chemical products sector and is not adequately reflected in historic trends. For example, the potential value of minerals contained in the brines of Great Salt Lake has recently induced two large companies to build extracting facilities adjacent to the lake. The OBE-ERS projections did not define physical quantities of output for this activity. The implications of these developments should be studied particularly with respect to competing water uses. Study of the effects of continued decline in the stage of Great Salt Lake is required, particularly in the absence of a management program such as the diking plans described under the Great Salt Lake subregional plan.

Population Growth and Industrial Expansion

The impact of population projections and different population distributions should be analyzed as should the impacts of industrial expansion. The water required for municipal and industrial use represents over one-half the projected increased use for the 1965-2020 period. Accordingly, changes in growth from that projected could result in major modifications to the plan. Two subregional plans present alternative per capita water use rates and modified industrial water requirements. More study is needed to determine adequate water use rates in this arid Region. Alternative industrial activities, including substitution of light manufacturing for heavy, high water use industries, may be appropriate. Population distribution could be studied in more detail in an attempt to reduce the conversion of irrigated land to urban, industrial, and other uses. Studies of population distribution are needed to evaluate the desirability of establishing new communities in areas where environmental effects would be minimized.

Importation of Products

As the cost of water in the Region rises, due to high cost of development and increased competitive uses, products may be produced cheaper elsewhere. An alternative to importing water and further development of local sources is to meet part of this Region's demands in areas outside the Region where water is more plentiful. This could apply in particular to industrial products requiring large quantities of water and possibly to agricultural commodities which could be imported. Broader adoption of this concept would result in economic impacts to growth and development.

The Utah portion of the Region is water deficient and coal reserves are remote to sources of water supply and load centers. The reserves of coal and water in the Upper Colorado Region suggest that importation of electrical energy would be more feasible than conveyance of both coal and water to the Wasatch Front area of Utah. A present State goal is to encourage economic growth in areas outside the Wasatch Front. This makes a power import alternative appear sound, relating to Utah's goal. The acute air pollution problem, a growing concern to Wasatch Front citizens, is perhaps another valid reason for importation of large quantities of power and less generation in this area.

Livestock Production

Beef, sheep, and dairy production have been the major livestock enterprises. Pork production has not been significant. The OBE-ERS projections show only a slight increase in pork production by 2020. A major pork enterprise recently has been launched in the Great Salt Lake Subregion. The impact of this and similar enterprises may require adjustments in the national allocations of food and fiber.

Feed Grain Production

Under OBE-ERS projections, the Region would depend on major imports of feed grains for livestock and poultry production. An alternative might be for the Region to produce a larger portion or possibly all of its feed grain requirements. Adopting such alternatives while retaining the other OBE-ERS projections as given, would result in increased land and water requirements.

Land Treatment

The input-output model was used to evaluate the difference between the projected land treatment to meet OBE-ERS and the projected ongoing program. Between 1965 and 2020, the ongoing program is projected to treat 27 million acres. To meet OBE-ERS projections, the number of acres treated would be 39 million. The ongoing program will generate a $191 million increase in gross regional product and 6,000 more regional employment. Higher alternative levels of land treatment should be investigated to optimize the benefit of these programs.

Gaming Industry in the Western Subregions

The gaming industry in the western subregions is not identified in the regional projections. Nevada State projections indicate that this industry will increase significantly and will be a major contributor to the economy of the western subregions.

PART VII

ADDITIONAL WAYS OF MEETING NEEDS

The plan draws upon well-established development and management practices. Not all of these result in optimum use of the water and related land resources. Many technological advances and improved management techniques currently under development were not included in the plan but may in the future be used more widely. The following pages discuss the current status and potential of several means of improving water and related land resources use.

Water Supply Elements

The following paragraphs describe various methods of increasing the available water supply.

Desalting

A comprehensive program of developing and applying necessary technology to produce low cost fresh water by desalting saline and brackish water is being conducted by government agencies and industrial firms. Several pilot plants utilizing distillation processes are in operation. Included are single-, dual-, and triple-purpose plants using nuclear power as the energy source.

The Wasatch Front presents a unique opportunity for desalting. The brackish water (1,200 - 3,000 ppm) now entering Great Salt Lake from the Bear, Weber, and Jordan Rivers could be desalted to meet future demands for potable water and the Great Salt Lake used as a natural brine disposal area. A joint feasibility study has been completed by the Office of Saline Water, Atomic Energy Commission, and Utah Division of Water Resources. A reconnaissance study has been initiated in Nevada to determine desalting potential. There are wide ranges of contaminants and salinities which in some cases are more difficult to treat than sea water. Due to the volume limits of brackish water sources, plants may be small. Membrane, electrodialysis and reverse osmosis, and ion exchange processes appear to have the greatest potential in these situations. The problems of these processes are membrane life, membrane cost, quantity of fresh water produced per square foot of membrane surface, and high operating temperature.

Weather Modification

Weather modification techniques to increase the water supply are an important element in water resource planning especially in this arid Region. These techniques are expected to become more widely utilized as additional knowledge of cloud physics and the effects of nucleation are mastered. Although the term weather modification includes research into possible means to dissipate fog, suppress hail, stop lightning, stifle tornadoes, and deenergize hurricanes, present interest is to enhance precipitation.

Progress has been made in increasing precipitation, not only in the Pacific Southwest, but also in other parts of the world. Since 1966, considerable advances have been made, not only in determining when and how to apply the present techniques of cloud seeding, but also in more accurately evaluating the effects. Evaluating results is a major problem in weather modification research, since the variation of the precipitation realized from normal storms covers a much wider range than the increase in the precipitation of a particular storm which has been artificially stimulated.

Studies are being conducted in both the Wasatch Mountains along the eastern boundary of the Region and in the Truckee basin along the western boundary. An increase of 15 percent in precipitation is anticipated using present methods. It is generally agreed that current methods of cloud seeding will be greatly improved as research continues. The annual potential increases in runoff have been estimated as follows: Bear River Subregion, 370,000 acre-feet; Great Salt Lake Subregion, 310,000 acre-feet; Sevier Lake Subregion, 80,000 acre-feet; Humboldt Subregion, 60,000 acre-feet; Central Lahontan Subregion, 100,000 acre-feet; and the Tonopah Subregion, 50,000 acre-feet.

Evaporation Reduction

There are over 1.7 million acres of water surface in the Region. With evaporation losses on the order of 50 to 100 inches annually, the potential for water savings through evaporation reduction is great.

Development of effective evaporation retardant agents has been studied under many conditions but has proved to be unacceptable. While several agents are effective in reducing evaporation up to 65 percent, the major problem encountered is maintaining a film over the water surface because of wind action and boat traffic. Other problems include deterioration by microorganisms, solubility and evaporation, and the impact on insects and wildlife caused by the film.

Basic research is needed to learn more regarding the phenomena occurring within the air-water boundary, and to discover methods and materials for evaporation retardation superior to those that have been used.

Phreatophyte Control

Most of the estimated natural ground-water discharge of 2.3 MAF annually is discharged by evapotranspiration from phreatophytes. Control of phreatophytes adjacent to streams ordinarily has been attempted by mechanical or chemical eradication. Replacement of vegetation on some areas for erosion control and increased beneficial use has followed eradication. Another method is developing ground water by withdrawal through wells from the ground-water sources serving phreatophyte areas.

Phreatophyte control or removal along stream channels and the upper flood plains may lead to increased yield of streams by decreasing ground-water discharge. Adverse effect on wildlife habitat and environmental values may require mitigation measures and revegetation.

Vegetal Cover Manipulation

Vegetative manipulation or management is a recognized method of water yield improvement. It may be directed toward either using the precipitation in place, or increasing the yield, controlling timing of streamflows, and improvement of quality in streams or springs.

Generally, the manipulation of vegetation to increase water yield is limited to the mountains or areas where annual precipitation is greater than about 15 inches and where water stored in the soil mantle exceeds field capacity. In this case, reducing the water used by vegetation makes more water available to drain through the soil profile and become streamflow. In the lowland, where there are significant areas of phreatophytes, actual increase in yield may be lost by evaporation, rather than evapotranspiration, unless the water is immediately diverted to beneficial use. A promising opportunity to increase water yield in the mountains is to convert aspen stands to grass.

Water Supply Management

Management methods which can be used to extend limited water supplies include: storage, both surface and underground; revegetation; flow measurement to improve distribution; hydrometeorological forecasting; and improved flood forecasting.

Water Storage

About 60 to 80 percent of the surface water supply is discharged from the snowpack in a 3-month period of spring runoff. This emphasizes the need to provide regulatory storage to utilize the supply at the time and location of need.

Subsequent to development of storage outlined in the plan, infrequent or localized unregulated flow will occur. Development of the remaining supply will require long-term carryover. Cost of such storage appears to preclude additional development unless new methods are found to build reservoirs more economically, or better coordination of the use of surface and subsurface storage is achieved.

The use and management of ground-water reservoirs is limited by inadequate technology for extensive artificial recharge. Without artificial recharge, ground-water development will be limited to the "safe yield" obtained by natural recharge. Until technology is developed for storing large surpluses of water underground, the limits set by nature cannot be exceeded without depleting one-time ground-water storage. Optimum management of the total water resource is not possible without this technology.

Technology is advancing in geophysical, geochemical, seismic, sonar, and other sensors, but these still provide only localized data. Advances are needed in sensors that penetrate below the land surface and into ground-water reservoirs. Advances are needed also in the principles of sedimentation and of other determinants of permeability, that will permit reliable use of data. Similarly, for recharge to and discharge from these reservoirs, there is need for development of physical principles and of sensors that will measure pertinent parameters at representative points. These technologic advances will doubtless be expensive, but present procedures are also expensive and inadequate.

Snowfield management includes measures to induce snow accumulation and modify the rate of snowmelt, but does not significantly increase the total yield. Any proposed program should be preceded by careful study of the effects on hydrologic, biologic and esthetic factors of the environment.

Revegetation

Revegetation includes seeding brushland to grass or restoring destroyed grasslands. This does not increase water yield, but may improve water quality by controlling erosion. The grass may use the same amount of precipitation as the native vegetation that previously occupied the area. Revegetation is of significant importance since

Improved Flood Forecasting

The present system for collecting information on potential flooding and the flood warning system are inadequate in most areas. The flood warning system does not provide sufficient time for evacuation of people and contents of buildings from flood plains or construction of emergency measures for protection of property. Future improvements in the system should provide for:

1. Expansion of the data reporting network, principally in the area of telemetry from remote area locations.
2. Satellite instrumentation and communication capability to provide:
   a. surface temperature field,
   b. temperature-moisture profile of the atmosphere,
   c. snow area and depth determination.
3. Increased and improved radar coverage for determining precipitation rates and amounts.
4. Establishing more community flood warning programs.
5. Upgrading computer facilities to provide for more rapid data processing and increased research capabilities.
6. Increased research to improve hydrologic models.

Nuclear Explosives in Water Development

The controlled use of nuclear explosions offers a significant potential for dollar savings in the future construction of large-scale water resources development projects. Its future role will likely be to complement conventional chemical explosives and mechanical excavation methods. Potential applications are numerous. One possibility is the forming of highly permeable underground water storage space, thereby reducing evaporative losses associated with surface storage. Another possibility might be the storage of liquid wastes in nuclear explosion cavities in otherwise tight geological formations. One of the present disadvantages of the use of nuclear devices is the possible contamination of water by radioactive materials.

Electric Power Generation

Several techniques of electrical generation which would bypass the heat cycle are under laboratory study. These direct conversion processes hold promise of simpler machinery and fewer by-products to affect the environment. A breakthrough in any one of them, which could make its use in central station generation feasible, would produce fundamental change in the power resource picture.

it can result in increased forage production and other benefits. Revegetation may reduce the demand on the water supply to the extent it replaces an equivalent value of feed grown in irrigated areas.

Flow Measurement Techniques

Improved water flow measurement can significantly improve the reliability of data and provide water management controls. Electronics is being adapted to replace mechanical equipment for measuring stages and velocities. Equipment to measure tracer materials helps determine the rate of movement of water. Unmanned water quality monitoring stations record the concentration of sediment and many solutes at sites of special interest. Improvements in instrumentation and communication will make up-to-date data available for optimum water use to help control pollution and provide flood warning.

Techniques and equipment for monitoring underground flow need development. Advances in the use of tracer substances would aid in determing the nature of underground flow. Changes in chemical quality of water during its residence underground are not fully understood. Advancements in the study of aquifers and hydrologic budgets, and in the application of methods already known but as yet considered too costly for use in hydrology, would increase knowledge of the underground regimen of water. There is also need for more complete metering of withdrawals from ground water.

Hydrometeorological Forecasting

Forecasting cannot increase the amount of renewable water, but allows for better utilization, management, and control of existing supplies. The ability to collect selected data when and where it is needed, coupled with the use of computers to rapidly evaluate and correlate these data, promises many improvements in the field of hydrometeorological forecasting.

One of the greatest impacts on forecasting in the last few years has been the advent of the satellite program. A multitude of experiments are currently in progress, including the measurement of vertical distribution of temperature in the atmosphere, the collection of surface data from remote land-based stations, attempts to relate satellite radar data to rainfall, and many others. Progress is also being made in automated surface collection systems which will provide more varied and timely information from existing sites and from data-sparse areas.

The most promising approaches for central station use are magnetohydrodynamics and controlled thermonuclear fusion reaction. Other direct conversion processes include the fuel cell, the photoelectric cell, and thermoelectric and thermionic generators. Some of these and possibly others may, with further development, prove economically feasible for isolated sources of power for communications, space and lunar stations, and eventually local (black box) generation.

The use of geothermal energy for the generation of electric power is also receiving increased attention. At present, it does not appear that geothermal energy will become a major source for electric energy, but there are a number of sites where geothermal power developments are feasible. If restrictive legislation on air pollution were to be enacted, if fossil fuel prices were to raise substantially, or if the use of nuclear power plants were restricted, development of a great many additional geothermal sites might be undertaken.

PART VIII

CONCLUSIONS

After a comparison of regional resources and the OBE-ERS projections presented in this report, the following conclusions seem valid:

1. The resources within the Region are generally capable of meeting OBE-ERS projections although some conflicts of use arise.

2. The total water resources supply is sufficient to meet the needs. The physical availability, quality and location in relation to place of use, priority of need, legal and administrative constraints, and cost restrict or limit the reasonable availability. These limitations on availability indicate augmentation may be more feasible.

3. All water is presently being used in some manner; however, future demands will require a change in the pattern of use.

4. Intensive utilization of water including reuse and higher efficiencies will become necessary.

5. The quality of surface and ground-water supplies would generally decrease with more intense utilization. Treatment of municipal and industrial return flows and streamflow regulation would be required.

6. Terminal lakes are receding and will continue to recede at an accelerated rate as depletions increase.

7. An abundance of land exists for all purposes; however, changes in use will be required to meet the needs.

8. Substantial increases in crop yields per acre are indicated to be probable. These are dependent on adequate water supply of good quality, and on careful management including better fertilizers and insecticides.

9. Agricultural production as projected by OBE-ERS can be achieved in all time frames.

10. Range forage production is expected to increase substantially by 2020, even though considerable grazing land is lost to other uses.

11. Proper use and management is necessary to suppress erosion and improve watershed conditions.

12. Known and predicted mineral resources are sufficient to maintain the present growth pattern of the mining industry. Mineral production is related to national rather than regional needs.

13. Continuing development will increase the potential for flood damages. All damages cannot be prevented, but a reasonable level of protection is feasible.

14. Abundant fish and wildlife resources exist. Increased land and water use would deplete some habitat, but most species are not threatened.

15. The recreational demands will increase especially near urban centers. Satisfying these demands will require development in these areas; however, large open space and scenic areas are available.

16. Multiple use planning and adequate zoning are necessary to control conflicts between uses.

17. The plan does not meet or consider all social and environmental demands.

18. Present legal and institutional constraints could limit the economic growth and development.

PART IX

RECOMMENDATIONS

Adoption of the framework plan as a general program for meeting future needs as determined from the OBE-ERS projections is recommended. Detailed studies will be required subsequent to implementing the various elements of the plan. The data, conclusions, and recommendations assembled herein, along with the experience gained, form a basis for outlining future investigations.

Further study of alternative means of meeting needs is required in the near future. A comparison should be made of the advantages of importing additional water to the Region or development of residual inbasin supplies. Consideration of environmental factors should be given more emphasis as additional data become available.

Specific recommendations basic to the needs and development are listed below:

1. Periodic review and updating of the framework plan should be scheduled and funded to incorporate future trends, additional data, State Water Plans, and related investigations.

2. More detailed studies should be made of the interrelationship of conjunctive use and management of ground-water and surface water resources. Studies of this type are needed on all major river systems. Areas of immediate need include Carson Valley, Truckee Meadows, and the Bear River system. The findings of a similar study on the Sevier River system should be implemented. Necessary legal and institutional arrangements should be made to facilitate implementation.

3. Implement management programs and install the necessary control facilities to increase the efficiency of water uses. Programs should be implemented to curtail increasing urban water per capita use rates. Present rates should be reduced where use is excessive. Consideration should be given to maintaining minimum streamflows to support fish habitat and water quality needs.

4. An inventory should be made of existing phreatophyte areas and playas to determine the possibilities for water salvage.

5. More basic data are needed to determine the extent of natural recharge and the possibilities of artificial recharge of ground water to better utilize the water resources.

6. A detailed study should be made of the Walker River system t determine ways to improve water quality and maximize the inflow to Walker Lake.

7. The Federal government should quantify its water need on Federal land, with consideration of both upstream and downstream uses

8. Land use studies should be made to insure proper management best use of land resources. Broad land use planning policies should be coordinated at all levels of government and implemented at the low level, consistent with proper management of land resources. Zoning i essential to regulate the development and use that is consistent with the capabilities and the limitations of the land.

9. Management of federal lands should be coordinated with state and private interests to provide the best utilization of all resource

10. Implement land management and treatment programs to increase forage production, enhance and protect wildlife habitat, and reduce floodwater and sediment production.

11. Develop improved plant species, fertilizers and insecticides that are more compatible with the environment and will increase food and fiber production.

12. More detailed study, coordinating state and federal planning efforts, should be made of all aspects of the recreation needs of the Region. Particular emphasis should be placed on obtaining basic data on recreation use, including user preferences. The unique natural resources characteristic of the Region should be given special recognition in land and water use planning to preserve these national assets.

13. Early action should be taken to resolve conflicts between development and preservation of potential wild, scenic, and recreatic rivers, as well as wilderness and scenic areas.

14. Develop and install the necessary instrumentation to monitor climatological data, streamflow, air and water quality, weather, and soil conditions.

15. Implement improved solid waste management methods, including recycling and reclamation. Strict enforcement of pollution control regulations is recommended.

GLOSSARY

ACRE-FOOT--The volume of water that would cover an area of one acr a depth of one foot, equal to 325,851 U. S. gallons or 43,560 cu feet. May designate a rate if related to time units. As used i report, commonly an annual rate as acre-feet, thousands of acre- or millions of acre-feet, per year.

ACTIVE STORAGE (USABLE STORAGE)--The volume normally available for release from a reservoir below the stage of the maximum controll level.

ALLUVIAL FAN--The outspread sloping deposit of detrital material b down by the action of water from neighboring elevations to a pla open valley bottom, formed roughly in a fan or cone shape.

ANIMAL UNIT MONTH (AUM)--A measure of forage or feed requirement t maintain 1 cow for 1 month.

AVAILABLE WATER--Water that is physically available in some degree available water as used in this report. Nonhydrologic factors, may inhibit the development of physically available water includ quantity and quality requirements for the intended use, the loca of the water in relation to the intended place of use, the degre need, various legal and administrative constraints, and the comb effect of these on the actual cost of development.

BENEFICIAL USE OF WATER--The use of water for any purpose from whi benefits are derived, such as but not limited to domestic, irrig industrial supply, recreation, fish and wildlife use, or power d opment.

BENEFICIATION--Part of a fertilizer manufacturing process in which fertilizer material is concentrated, also the removal of unwante constituents from mineral ores to improve the grade or quality o ore used.

BIOCHEMICAL OXYGEN DEMAND--The quantity of oxygen used in the bioc cal oxidation of organic matter in a specified time, at a specif temperature, and under specified conditions.

BRACKISH WATER--Saline water having a mineral content ranging from 1,000 mg/l of dissolved solids to that of sea water.

BRINE--Water having a dissolved-solids content of greater than 35, mg/l (milligrams per liter).

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GREAT BASIN REGION COMPREHENSIVE FRAMEWORK STUDY. APPENDIX XVII--ETC(U)
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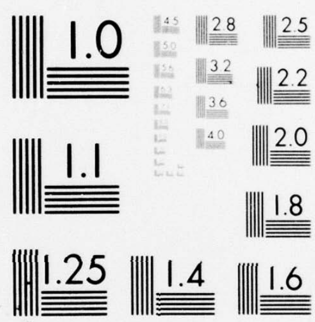

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CLOSED BASIN--A basin is considered closed with respect to surface flow if its topography prevents visible outflow. It is closed hydrologically if neither surface nor underground outflow can occur under present conditions.

CLOUD SEEDING--Treating clouds with minute particles of matter, usually silver iodide crystals, to provide additional nuclei to increase precipitation.

COMMERCIAL FOREST LAND--Forest land that produces more than 20 cubic feet of industrial wood per acre annually.

COMPREHENSIVE FRAMEWORK PLAN--A plan for water and related land resources development that considers the physical, economic and social factors to the year 2020.

CONJUNCTIVE USE OF WATER--The integrated use of surface and subsurface water supplies and facilities, normally involving storage above or below land surface of surplus waters when available, for use during periods when water supplies are deficient.

CONSERVATION RESERVE--Land taken out of production during times of surplus and seeded to grass to protect it from erosion until it is again needed for crop production.

CONSUMPTIVE USE OF WATER--The removal of water from a system by discharge to the atmosphere and incorporation in the products of vegetative growth, food processing, industrial processes, or other use.

CRITICAL AREAS--Land areas where vegetal cover has been destroyed and where serious runoff and erosion are occurring.

DEAD STORAGE--The volume in a reservoir below the lowest controllable level.

DEPENDABLE YIELD (streamflow)--Expressed herein as the average streamflow for consecutive intervals of 1 to 10 years and plotted as a percentage of average annual flow for the 1931-60 reference period. It is not the same as dependable yield obtainable with reservoir operation.

DEPLETION OF WATER--Water consumed and no longer available for supply. Equivalent to consumptive use plus natural losses by evaporation and transpiration of surface water or ground water.

DESALTING--Removal of mineral dissolved solids from saline water by artificial methods.

DISAGGREGATE--To break a figure down into the segments that make it up.

DRY CROPLAND or DRYFARM LAND--Non-irrigated cropland that depends on precipitation to produce a crop. Small grain crops and alfalfa are grown on an alternate crop and fallow basis where annual precipitation is not sufficient to produce a crop.

ELECTRODIALYSIS--A process for removing ionized salts from water through the use of ion-selective membrane and electric current.

EVAPOTRANSPIRATION--The process by which water is transpired by plants and evaporated from plants and surrounding soil. Quantitatively it is usually expressed in depth of water during a specified period of time.

FALLOW--Land cultivated but not seeded during the year. Used to store soil moisture and make it available for the next year's crop and to control weeds.

FLOOD FORECASTING--Projecting the probability of floods by frequency, size and location for both immediate and long range planning.

FLOOD PLAIN MANAGEMENT--Planning and implementing measures to best utilize land and water resources bordering streams that overflow during floods.

FLOODWAY--The channel of a river or stream and those parts of the flood plains that carry and discharge floodwater.

FOSSIL FUEL POWER PLANTS--Electric power generating plants using fossil fuels such as coal, gas and oil as a source of energy.

FRESH WATER--Water having a dissolved-solids content of less than 1,000 mg/l.

FROST-FREE PERIOD--Average length of time between latest spring and earliest fall frost generally below 32° F.

GEOTHERMAL POWER PLANT--An electric power plant using heat from within the earth as a source of energy to turn turbine blades.

GIGAWATT (gw)--One million kilowatts.

GREENBELT--A linear extension of land or land and water which fulfills an open space function.

GROSS REGIONAL PRODUCT--The market value of finished goods and services produced by the Region's economy within a specified period of time. GRP, a valuable measure of regional economic activity, is generally expressed at an annual rate.

GROUND WATER--Subsurface water that occurs in the zone of saturation.

GROUND-WATER DISCHARGE--Outflow of water from a ground-water reservoir. May be accomplished naturally or artificially. However, in usage in this report, mostly refers to natural discharge by evapotranspiration of phreatophytes, spring discharge, and seepage to streams or lakes.

GROUND-WATER RECHARGE--Inflow of water to a ground-water reservoir. May be accomplished either naturally or artificially.

GROUND-WATER STORAGE--Literally water stored underground. As used in this report, the vertical dimension arbitrarily comprises the upper 100 feet of saturated valley-fill deposits. The ground-water storage values represent only a fraction of the total amount of stored ground water. The quantity so computed is many times the average annual value for natural ground-water recharge or discharge, i.e., the renewable ground-water resource. For consideration of use of this ONE-TIME GROUND-WATER STORAGE RESERVE, the volume can be expressed as an average annual rate for an arbitrarily selected (50 in this report) period of years. Ground-water storage reserve is thus a TIME-LIMITED SUPPLY.

GROUND-WATER WITHDRAWAL--The withdrawal of water from a ground-water system. Commonly refers to ground water withdrawn by pumping. However, withdrawal is a broader term in that it includes water withdrawn through naturally flowing wells, man-made drains and tunnels, and also may include discharge from springs.

HYDROLOGIC SUBREGION--A major subdivision of a region based upon drainage boundaries and not on political boundaries.

HYDROMETEOROLOGICAL FORECASTING--Predicting water in the atmosphere as rain, clouds, snow, hail, etc., and its effects on flood control, agriculture, etc.

IDLE LAND (irrigated)--Land with a developed irrigation system that receives no irrigation water in any given year.

INTERTIE--A transmission line permitting a flow of energy between the facilities of two electric systems.

MAGNETOHYDRODYNAMICS--A method of producing direct electric current by means of heated gas or liquid metal moving at high rate of speed through a magnetic field provided by powerful electromagnets.

MEAN ANNUAL (-)--As used here, the arithmetic average for the 1931-60 reference period as applied to precipitation and temperature. As applied to streamflow, the recorded values are modified to reflect the 1965 level of development.

MEGAWATT (mw)--A measure of electrical capacity. Equals one million watts or one thousand kilowatts.

MEMBRANE PROCESS--A method of desalting water using a thin filmlike sheet or membrane which selects the flow of specific ions.

MITIGATION--Providing services or facilities to compensate for project detriments.

MODIFIED FLOW--Natural streamflow adjusted for the effects of development. In this study, the streamflow records for the 1931-60 reference period were adjusted for the 1965 level of development.

MULTISTAGE FLASH DISTILLATION--Distillation process for desalting water utilizing the principle that water boils at progressively lower temperatures as it is subjected to progressively lower pressures.

NOMINAL WATER SUPPLY--As used in this report, it is that part of the surface water and ground water renewable resources identifiable, as principal streams, depletions upstream from principal stream key gaging stations, secondary and minor streams, and natural groundwater discharge exclusive of that in areas of upstream depletion. It includes a wide range of special conditions, and costs to make it available. It does not include reuse.

NUCLEAR PLANT--A plant where nuclear reactors provide the heat energy to produce electric power.

OPEN SPACE--Any predominantly undeveloped land and water area which has value for managed resource production, natural resource preservation, Health Welfare and well-being, Public Safety and service corridors.

PARAMETER--A characteristic element or constant factor.

PEAKING ELECTRIC POWER--Power from generators installed to be operated for short periods when loads are highest.

PERENNIAL YIELD (GROUND WATER)--The amount of water that can be withdrawn from the ground-water reservoir without exceeding the natural recharge.

PERSONAL INCOME--Includes income received by all individuals from whatever source. It includes wages, salaries, proprietors' income, rental income, dividends, interest, and the difference between government transfer payments and personal contributions for social security.

PHREATOPHYTE--A plant that obtains its water from the zone of saturation, either directly or through the capillary fringe. As used in this report, it consists of non-agricultural vegetation including Tamarisk (salt cedar), greasewood, cattails, etc.

PHYSIOGRAPHIC BASIN--An area bounded by definite physical geographic surface features.

PRINCIPAL STREAMS--The principal streams in the Great Basin Region have been designated as Bear, Weber, Jordan, Sevier, Humboldt, Walker, Carson, and Truckee Rivers. The flow of these streams is represented by the gaging station record at or near their respective maximum-flow reaches. In the case of the Walker, Carson, and Truckee Rivers, flow passing the gaging station at or near the Nevada-California State line is used as the flow of reference.

RAIN SHADOW--Area of low precipitation on the side of the mountain opposite to the prevailing direction of storm paths.

RECREATION DAY--A statistical unit of recreation use consisting of a visit to an area by one person for all or a portion of one 24-hour period.

RECREATION DEMAND--The quantity of participation in outdoor recreation activities that will occur based on trends of increased participation rates.

RECREATION NEED--The difference between demand and supply expressed in units of recreation days or acreage requirements.

REFERENCE PERIOD--The 30-year base period, that is, 1931-60, used in the Great Basin Region study, principally for climatic and streamflow records.

RENEWABLE WATER SUPPLY--That part of the water supply that is replaced on the average year after year, generally by natural processes, but locally may include artificial or induced conditions.

RESIDUAL WATER SUPPLY--The nominal water supply from which is subtracted depletions of principal uses. In this report the defined uses at the 1965 level of development were used. Note, however, that essentially all water in the Region is removed by evapotranspiration. The question then is the degree to which principal uses include natural uses.

RETURN FLOW--That part of a diverted flow not consumptively used and which returns to a surface water supply.

REVERSE OSMOSIS--A membrane process of desalting water utilizing the principle of osmosis and pressure.

RUNOFF--That part of the precipitation that naturally occurs in surface streams.

SALINE WATER--Water having a dissolved-solids content between 1,000 and 35,000 mg/l. Slightly: refers to range of 1,000 to 3,000 mg/l; moderately: refers to range of 3,000 to 10,000 mg/l; very saline: refers to range of 10,000 to 35,000 mg/l.

SECONDARY STREAMS--The usage in this appendix is restricted to those streams in the Region lying outside the upstream areas of the principal streams and that have flows in excess of 1,000 acre-feet per year. The larger ones have annual flows of as much as about 45,000 acre-feet. This designation specifically excludes streams in the upstream areas, some of which have annual flows exceeding 100,000 acre-feet.

SEDIMENT--Soil material dislodged by rainfall or streamflow, carried by runoff water, and deposited in reservoirs, lakes or on flood plain lands.

SNOWFIELD MANAGEMENT--Manipulating the snow pack on high water yielding areas using snow fences, avalanches, etc., to control the time of snowmelt and its appearance as streamflow.

SNOWMELT RUNOFF--Runoff primarily responding to melting snow during the spring months, sometimes called spring runoff.

STREAMFLOW--May be the same as runoff but as a more general term includes flow affected by diversion or regulation.

SURFACE WATER--Water on the land surface in streams, lakes, and reservoirs.

SYNTHETIC HYDROLOGY--The process of predicting runoff using rainfall, soil and plant cover information.

TERMINAL LAKE--A lake at the downstream end of a stream system in a closed basin or closed group of basins. Used in this report for permanent lakes of this type.

TERMINAL SINK--A usually flat area at the end of a river or stream system in a closed basin where the inflow, either on the surface or underground, is balanced by evaporation.

THERMAL STEAM PLANTS--Electric power generating plants utilizing heat as the source of energy.

THERMAL ELECTRIC POWER--Power generated using heat energy from any source, including Geothermal Nuclear, fossil fuel, etc.

TOTAL DISSOLVED SOLIDS (TDS)--Total quantity of solids present in solution quantitatively expressed as milligrams per liter. Typically the residue of evaporation.

TOTAL GROSS OUTPUT--The total value to the producer of all goods and services produced. It measures the value of goods and services at each stage in the production process and is, therefore, an accumulation of value until the good or service reaches the final consumer.

TOTAL STORAGE--The volume of a reservoir below the maximum controllable level including dead storage.

UPLAND WILDLIFE--All wild animal life found primarily in non-aquatic habitat.

UPLAND GAME--Small game birds and mammals found primarily in non-aquatic habitat.

USABLE STORAGE (ACTIVE STORAGE)--The volume normally available for release from a reservoir below the stage of the maximum controllable level.

VALUE ADDED--A measure of the costs of producing the finished goods and services that goes to the final markets described in gross regional product. It includes wages, salaries, profits, rents, interest, depreciation, and federal, state, and local taxes. Value added is not only a valuable measure of total regional economic activity, but also indicates the contribution of single industries to the economy.

VERTICAL TUBE DISTILLATION--A process of desalting water by distillation utilizing a series of vertical heat exchanges.

VECTOR--An insect or other invertebrate that is a carrier of a disease producing virus and which transmits infection by biting or depositing infective material on the skin, on food, or other objects.

WATER SUPPLY--The part of the water resources considered to be available for use. Sometimes used as equivalent to water resources. Commonly used as the supply of water developed or subject to development by and available to man. In the latter sense, cost or economics are implied. Thus availability is subject to certain constraints and costs, which, in turn, are different for different uses. The latter usage is preferred and used in this report.

WATER TREATMENT (effluent)--Any mechanical or non-mechanical plant or other facility used for the purpose of treating, stabilizing or holding effluent water. Includes primary, secondary and tertiary treatment. Primary treatment removes from sewage of larger solids by screening, and of more finely divided solids by sedimentation. Secondary treatment is the further treatment of the effluent from primary treatment by biological, physical, and, in some cases, chemical means. Tertiary treatment is the additional treatment of effluent, beyond that of secondary, in order to obtain a very high quality of effluent.

WATERSHED MANAGEMENT--The analysis, protection, development, operation or maintenance of the land, vegetation and water resources of a drainage basin for the conservation of all its resources for the benefit of man.

WATERSHED REHABILITATION--Improving the vegetal cover and soil protection of a watershed by such means as seeding, grazing management, tree planting, etc.

WEATHER MODIFICATION--Controlling precipitation by such methods as cloud seeding.