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FEASIBILITY OF SERVING THE MOJAVE WATER AGENCY FROM THE STATE WATER PROJECT

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FOREWORD

In November 1960, the California Water Resources Development Bond Act, (Chapter 6 (commencing with Section 129), Part 6, Division 6 of the Main Code) was approved by the State's electorate, paving the way for the construction of the State Water Project. Since that time, many local water service agencies throughout the State have applied to the Department of Water Resources for consideration as potential contractors with the State for water service from the proposed facilities. Several water agencies have been organized and formed since November 1960 expressly for the purpose of obtaining supplemental water supplies from the State facilities for the areas they represent.

Prior to executing contracts for water service with public agencies, the Department of Water Resources made studies of those agencies and the areas encompassed by them to determine the propriety of entering into such contracts. These studies were made with the goal of evaluating (1) each area's future demand for supplemental water supplies; (2) the legal ability of each agency in question to enter into a water supply contract with the State; (3) the engineering feasibility of providing the proposed water service; (4) the financial ability of each agency and its constituent area to bear the financial burden necessarily imposed upon it by a water supply contract with the State.

The results of the studies made for each agency, along with significant incidental and supporting material, have been embodied in separate reports which have or will be published by the Department of Water Resources for the benefit of interested agencies and persons. This bulletin, dealing with the Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory in San Bernardino County, is one of a series of such publications.

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CHAPTER I. INTRODUCTION

Early in 1962, the Board of Directors of the Mojave Water Agency asked the Department of Water Resources to consider the Agency as a potential prime contractor for water from the State Water Project and expressed its desire to enter into a water service contract with the State as soon as practicable. Pursuant to this request, the Department conducted an investigation to determine the engineering feasibility and economic justification of providing supplemental water to the Agency and to evaluate the financial capability of the Agency to support a water supply contract. An analysis of the facts gathered during this investigation led to the conclusion that the Agency did have the economic justification and financial capability required to enter into a water supply contract with the State.

As a result of these findings, the State and the Agency executed a contract on June 22, 1963, for a maximum annual entitlement of 44,000 acre-feet. Eight months after this contract was signed, the Agency expressed a desire to exercise its option for 6,800 acre-feet of additional water under the provisions of Article 8. An analysis of the Agency's request indicated that the Agency had the need and the financial ability to pay for this additional water. Accordingly, the contract was amended on September 28, 1964, increasing the Agency's maximum annual entitlement from 44,000 to 50,800 acre-feet. Since the contract was signed and amended before a report of the Department's investigations could be published, the report is being published at this time so that other interested water agencies and members of the public may be informed of the considerations that led to these actions. The water supply contract with the Mojave Water Agency expressly authorizes two smaller areas, the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory, which are located just to the south of the

Agency's boundaries, to join the Agency if they desire. If either of these areas had annexed to a contractor other than the Mojave Water Agency prior to December 1, 1964, and the contractor's entitlement had been increased as a result of these annexations, the maximum annual entitlement of the Mojave Water Agency would have been reduced by equal amounts up to a maximum of 1,500 acre-feet for each area under the provisions of Article 45(e) of the contract. Since the time limit expired without the annexations having taken place, the Agency's annual entitlements were unaffected by this contract provision.

In order to provide data that would be useful if either or both of these areas join the Mojave Water Agency, the basic data in this report have either been (1) presented separately for the Morongo Valley Community Services District, the Yucca-Joshua Tree Valley territory and the Mojave Water Agency or (2) presented for the Mojave Water Agency area and the total area under investigation. Whenever reference is made to the total area under investigation, the area will be referred to as the investigational area or the Mojave Water Agency service area.

Included in this report is a review of the region in which this area is located, a summary of its recent economic development and future economic potential, estimates of the area's future water needs, and a schedule of the probable costs of serving the investigational area with water from the State Water Project. The report also evaluates the economic and financial aspects of supplying water to this area from the State Water Project.

The Department of Water Resources has already undertaken a general investigation of the region in which the investigational area is located. Appendix A of the Department's Bulletin No. 78, entitled

"Long Range Economic Potential of the Antelope Valley - Mojave River Basin", considered the economic future of the Mojave Desert portions of Los Angeles, Kern, and San Bernardino Counties and provided a basis for projections of the areas' imported water demands. Appendix D of the same Bulletin, entitled "Economic Demand for Imported Water" and published in March 1960, modified the conclusions in Appendix A to bring the projections for the Antelope Valley - Mojave River area into conformity with the studies conducted for the balance of California. The present report was prepared to enlarge upon and modify the data appearing in Appendixes A and D to Bulletin No. 78 and to provide data that applies specifically to the area under investigation.

Description of the Service Area

Characteristics of the Locale

The Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory are all located in the Mojave Desert portion of San Bernardino County. In spite of a few rapidly growing communities, the area is still sparsely settled in comparison with other sections of Southern California. Outside the major urban centers, the area is an arid expanse of mountain ranges, valleys, dry lakes, and hills dotted with creosote, bursage, and other vegetation characteristic of a desert scene.

The Mojave Water Agency is located in that part of the Mojave Desert lying north of the San Bernardino National Forest, east of the San Bernardino-Los Angeles and San Bernardino-Kern County Line, south of the Fort Irwin Military Reservation, and west of the line between Range 4 East and Range 5 East, S.B.B. & M. The Agency has a total area of about 4,300 square miles and contains about two-thirds of the population of the desert portion of San Bernardino County.

The Morongo Valley Community Services District is located about 15 miles south of the Mojave Water Agency's southeastern boundary. The area lies in a relatively flat basin between the San Bernardino and Little San Bernardino Mountains and has a total area of 17 square miles.

The Yucca Valley-Joshua Tree territory lies from 5 to 15 miles northeast of the Morongo Valley and encompasses 25 square miles of land in and around the communities of Yucca Valley and Joshua Tree. At its closest point, the territory's northern boundary is 12 miles south of the southern boundary of the Mojave Water Agency, while its southern boundary corresponds to the northern limit of the Joshua Tree National Monument. The area in which the Mojave Water Agency, and the two adjacent territories described in this survey are located, is shown on Plate 1, "Location Map and Proposed Local Distribution System".

Nearly all of the land within the Morongo Valley Community Services District and Yucca Valley-Joshua Tree territory and large parts of the area encompassed by the Mojave Water Agency lie on the floor of desert valleys at elevations ranging from 2,000 to 3,000 feet above sea level. The highest elevations are located along a series of mountain crests in the Mojave Water Agency area. The Calico, Ord, and Granite Mountain ranges in the eastern part of that area attain elevations ranging from 4,500 to 5,000 feet, while the crests of Dome and Red Mountains in the northern part of the area are each about 5,000 feet above sea level.

The climate of the Mojave Desert is characterized by high summer temperatures, low humidity, strong winds, and little rainfall. The average annual precipitation in the Mojave River Valley, the center of agricultural activity in the area, is about five inches, an amount so

small that irrigation is required for all major crops. Temperature extremes in the summer frequently exceed 100°F., and in winter often fall below freezing.

History of the Area

In 1776, a Spanish exploration party under the leadership of Father Francisco Garces passed through the Mojave Desert on its way to Mission San Gabriel. These were the first white men known to have crossed this barren land. Fifty years later, the same desert was traversed by Jedediah Smith and other western trappers whose pioneering led to the establishment of trading caravans linking New Mexico to Southern California. Many gold-seeking immigrants, some of whom endured incredible hardships in Death Valley, also passed through the area on the way to the California gold fields in 1849.

By the 1860's, the desert had become an important passageway for the movement of freight and passengers between Salt Lake City and the emerging cities of Southern California. To protect travelers from Indian attack, the government established a series of forts at strategic desert points. This military protection and the availability of supplies brought the first ranchers and agricultural settlers to the Victorville area of the Mojave River Valley.

At about this same time, groups of prospectors, spurred on by successful gold strikes in the San Bernardino Mountains, discovered a series of mineral deposits that formed the basis for the development of large-scale mining in the county. The most notable mining districts were established in the Calico Mountains, 10 miles northeast of Barstow, where rich deposits of silver and borax were mined in the 1880's and early 1890's, and the

Randsburg district, located partly in Kern County and partly in Los Angeles County, which yielded large quantities of gold, tungsten, and silver between 1890 and 1925. The decline in price levels and the exhaustion of high-grade ores has led to the virtual cessation of mining in these districts in recent years. Of more immediate importance to the region described in this survey are the large limestone deposits which led to the establishment of the first cement manufacturing plant near Victorville in the early 1900's and provided the basis for what has today become a major cement producing industry.

The completion of the Santa Fe Railroad through the Mojave Desert in 1883 gave the area its first railroad link with the nation. An additional transcontinental line was established in 1905, when the San Pedro, Los Angeles, and Salt Lake Railroad was completed. As these lines were built, a number of new communities arose along the rights-of-way, including Barstow, Victorville, and Helendale, all of which are located within the Mojave Water Agency. Today, Barstow is a growing city as well as an important station for the Santa Fe Railroad, which maintains diesel engine shops and switching yards there.

One of the most important developments of recent years was the establishment of two major military installations within the Mojave Water Agency area during World War II - George Air Force Base near Victorville and the Marine Corps Supply Center near Barstow. These facilities have continued to provide an important source of job opportunities and have greatly stimulated the development of urban centers near them. Since the war, a number of new homes and recreational facilities have been built to meet the growing interest of permanent residents and vacationers in the desert region, a trend which has symbolized the area's potential for future development.

Land Classification and Present Land Use

The Department of Water Resources conducted a land use survey in the investigational area in 1958 for use in preparing Bulletin No. 78, "Investigation of Alternative Aqueduct Systems to Serve Southern California". A supplemental land use survey was made by the Department of most of the territory within the Mojave Water Agency in 1961. Data obtained from these two surveys were used to classify lands in the investigational area into both habitable and noninhabitable lands.

The classification for the Mojave Water Agency was made by combining the data obtained for the Lucerne Valley from the 1958 land use survey with the data obtained from the 1961 land use survey for the remaining portion of the Agency's area. The pattern of land use in the Lucerne Valley has remained relatively stable since 1958, so that the two sets of data could be combined with a minimum of distortion. Land classifications for the Morongo Valley and Yucca Valley-Joshua Tree territories were based entirely on data obtained from the 1958 survey.

In preparing estimates of habitable and nonhabitable lands, land areas in agricultural or urban use were identified and separated out from the total acreage under consideration. Of the remainder, the acreages of water surface, barren land, and other classes obviously unfit for agricultural or urban use were removed and classified as unusable land. Included in this latter category were lands that appeared to be too steep in topography or constituted washes and other nonproductive lands. The remainder of the land, along with lands presently in use, was deemed to be either habitable or irrigable. The Department's estimates of usable and nonusable land in the Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory, made in accordance with this procedure, are shown in Table 1.

TABLE 1

PRESENT AND POTENTIAL LAND USE

Type of land use	Acres in use		
	Mojave Water Agency[a]	Morongo Valley Community Services District[b]	Yucca Valley-Joshua Tree Territory[b]
Urban land[c]	13,100	600	600
Agricultural land[d]	26,100	-	-
Military land	61,000	-	-
Subtotal, present land use	100,200	600	600
Undeveloped usable land	1,632,800	4,800	14,400
Total usable land	1,733,000	5,400	15,000
Unusable land	1,000,000	5,500	1,300
Total land area	2,733,000	10,900	16,300

a. Estimates based mainly on 1961 data.
b. Estimates based on 1958 data.
c. Includes permanent and summer home tracts, public streets, railroads; includes undeveloped subdivisions with streets and utilities but no buildings.
d. Includes ranches, dairies, and other semiagricultural lands.

Restrictions on Future Development

The area described in this report offers many advantages conducive to future economic development. It borders one of the fastest growing metropolitan areas of the country, offers large quantities of vacant land suitable for urban development, and possesses a variety of mineral products of commercial value. For these and other reasons which will be discussed in Chapter II, it appears inevitable that the region will experience substantial economic growth. Nevertheless, there are a number of factors which may tend

to moderate economic development in the near future. Among these factors are climatic conditions, competition from other areas, and water supply problems.

While the area's low relative humidity should appeal to certain industries concerned with the need for low cost, outdoor storage, the hot summer climate probably discourages a number of persons who might otherwise settle there. In addition, the low rainfall, strong wind, and short growing season limit the kind of crops and restrict agricultural activities to those involving irrigation. The growing use of air-conditioning equipment by homes and industry, however, has made the heat much less of a deterrent than it once was and has contributed to the development of a more pleasant living and working environment.

Another factor tending to retard the development of the area under investigation is the competition it faces from other areas for homes, commerce, and industry. Most persons, for example, would probably consider the undeveloped portions of Ventura and Santa Barbara Counties to be more attractive areas in which to live and work than this semiarid basin. Future growth in the area under consideration would, therefore, depend to a large extent upon its ability to overcome this disadvantage by developing other advantages favorable to the development of urban activity.

The most critical factor affecting the future development of the area, however, is the adequacy of local water supplies. The supply of water is extremely important to the area's urban development, while agricultural production is almost completely dependent upon it. The area's future growth will be severely hampered without supplemental water since local water supplies are already overdrawn. The importation of water from the State Water Project will relieve this adverse condition and safeguard the area's potential for future economic development.

Description of Mojave Water Agency

The Mojave Water Agency was organized on July 21, 1960, for the primary purpose of contracting for water from the State Water Project. It was one of the first agencies to be organized with this function in mind. The major effort of the Agency during the short period of its existence has been directed toward ascertaining its future water needs, what facilities will be required for the distribution of water to retailers in its area, and the amount of water for which the Agency should contract with the State.

The Agency was created by Calif. Stats. 1959, Ch. 2146, p. 5114, commonly known as the Mojave Water Agency Law and hereinafter referred to as the enabling act. This legislation, together with certain amendments contained in Calif. Stats. 1961, Chs. 890, 1485, 1559, 1624, 2011, and Calif. Stats. 1963, Chs. 274, 546, 836, 1685, 1715, prescribes the Agency's boundaries, organization, management, financing, and other powers and duties.

General Powers

The general powers of the Agency are set forth in Section 15 of the enabling act.[1/] This section authorizes the Agency to "do any and every act necessary to be done so that sufficient water may be available for present or future beneficial use of the lands or inhabitants of the agency". The Agency is specifically authorized to develop, protect, and conserve water; to acquire water rights for any beneficial purpose; and to construct, operate, and maintain hydroelectric works. The Agency is also empowered to enter into any contract with the United States, the State of California, and any public or private corporation to carry out these powers. Provision is also made for

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1/ All section references herein are to the enabling act unless otherwise specified.

the Agency to apply to the State of California or the Department of Water Resources for its share of water made available by the State Water Project or any other supplemental water source.

Fiscal Powers

After the Agency had been formed, doubt existed as to whether it had adequate taxing powers under its original enabling act to meet the repayment requirements of the State Water Supply Contract which was then under consideration. To remove this doubt, amending legislation was introduced in the 1963 Regular Session of the State Legislature. The subsequent passage of this legislation substantially broadened the financial powers of the Agency. Section 16, as amended, empowers the Agency to levy charges for water sold by the Agency and to levy charges against pumping which, together, will pay not less than the variable costs due under any water supply contract with the State of California. In addition, the Agency is empowered to levy an ad valorem tax on land in an amount not to exceed $0.45 per $100 of assessed valuation for the purpose of paying all other costs, expenses, and obligations arising under such a contract with the State. If the $0.45 levy is insufficient to raise adequate revenue for such purposes, the Agency may levy a tax on all taxable property within the Agency, other than personal property to raise these funds. The Agency may also levy a tax, not to exceed $0.10 on each $100 assessed valuation on all taxable property in the Agency, exclusive of personal property, for the payment of the administrative expenses of the Agency.

Section 17.5 authorizes the Agency to borrow money and to incur indebtedness for any purpose for which it is authorized to expend funds. Such indebtedness shall be evidenced by notes of the Agency, issued by it,

and approved by two-thirds of the members of the Board of Directors of the Agency. Such notes, in any one fiscal year, shall not exceed an amount equal to two and one-half cents for each acre of land in the Agency; the interest rate thereon is limited to 6 percent per annum and their maturity to a period of five years.

Section 19 authorizes the Agency to issue general obligation or general revenue bonds to accomplish the purposes of the Act when authorized by a vote of more than two-thirds of the electors voting at an election. For such bonds the interest rate shall not exceed 7 percent per annum and they shall mature during a term not to exceed forty years.

Annexations and Exclusions of Land

Section 29 authorizes the Mojave Water Agency to annex additional land. Annexation proceedings may be initiated by a petition signed by at least 10 percent of those voting for the office of Governor at the last general election held prior to the filing of the petition. If one or more cities are included in the land proposed for annexation, the petition must be signed by at least 10 percent of the voters in each city voting in such an election. Section 29.5 provides that no territory, however, may be annexed to the Agency, if it is located outside the boundaries of San Bernardino County.

Section 32 provides that any tract of land included within the Agency may also be excluded from the Agency, on the initiative of the board of directors, if the board determines that the land will not be benefited by continued inclusion in the Agency or if it determines that the exclusion will be for the best interests of the Agency. Section 31 provides that exclusion proceedings may be initiated by a resolution of the board or by

a petition signed by the owners of land and improvements having an assessed value in excess of one-half of the assessed value of all privately-owned land and improvements in the tract proposed for exclusion. The board may then, after a hearing, order the exclusion of such land from the Agency. Section 32 further provides that property in territory excluded from the Agency will remain taxable by the Agency for the repayment of bonded indebtedness existing at the time of the exclusion.

CHAPTER II. PRESENT AND FUTURE DEVELOPMENT OF THE ECONOMY

As recently as 1940, the economy of the area under investigation was based largely on farming, railroad activity, cement manufacturing, and essential retail and service trades. While these activities continue to provide an important source of income to the area, its economic structure has since been strengthened by the establishment of a number of large and active military installations during World War II and by the postwar development of new homesites and resort facilities.

Economic development of the area is expected to be relatively moderate through the 1970's but gain momentum in succeeding years as population and industry expand outward from the Los Angeles metropolitan area to adjacent areas where conditions for growth are favorable. Future expansion of manufacturing and resort activities is expected to account for a significant share of this growth. While irrigated farm acreage is expected to decline moderately under the impact of advancing urbanization, agriculture should continue to constitute an important element of the economy during the projection period covered by this report.

Agriculture

Irrigated Agriculture

The first agricultural settlements in the investigational area were located along the Mojave River which usually flows as a subsurface stream but rises to the surface at short intervals along its reaches. The availability of these waters was a major factor in the early development of the area, since agriculture, in order to survive the arid climate of the Mojave Desert, must have a constant supply of water for irrigation. The

available supply of surface water soon proved inadequate, however, and the development of ground water was initiated shortly before 1900.

During the intervening years, the bulk of the irrigated acreage in the study area has continued to be concentrated along the Mojave River. The Department's Bulletin No. 101, "Desert Areas of Southeastern California, Land and Water Use Survey, 1958", presented historical data which indicated that about 10,000 acres of land were under irrigation in the Mojave River Valley by 1915. This total declined to about 6,000 acres in 1929, remained at that level until 1935 but more than doubled during the 15 years which followed when the large expanses of undeveloped land in the area began to attract farmers in increasing numbers. Since 1950, the amount of agricultural acreage has declined slightly, dropping from around 13,600 acres in that year to around 13,000 acres in 1958.

Since the turn of the century, many attempts have been made to develop other portions of the investigational area for agricultural purposes. Most of these attempts have ended in failure primarily because of insufficient supplies of good quality ground water. However, fertile soil and favorable ground water conditions have permitted the extension of irrigated farming into the Lucerne and Harper Valleys, where about 4,400 acres of land were under irrigation in 1961. There is virtually no agricultural activity in the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory at the present time.

The Mojave Water Agency's request for a water service contract with the State was based solely on urban water requirements. Nevertheless, to ascertain future demands for imported water, it was necessary to make projections of the area's irrigated farm acreage in order to determine the extent of agricultural depletion of local water supplies. In making

projections of irrigated crop acreages, the following influencing factors were given consideration: land availability, climatic conditions, the economic feasibility of producing particular crops, and the farmer's ability to pay for water use.

Estimates of payment capacities of the leading crops grown in individual portions of Southern California were made for the Department's Bulletin No. 78, and were presented in Appendixes A and D of that bulletin. These estimates were made by subtracting all production and overhead costs, except water costs, from gross income produced from specific crops. The payment capacities for adaptable crops in the area under investigation, as obtained from Bulletin No. 78, are shown in Table 2.

TABLE 2

PAYMENT CAPACITIES OF MAJOR IRRIGATED CROPS
IN THE MOJAVE WATER AGENCY AREA

Crop	Payment capacity per acre-foot of applied water
Alfalfa hay	$ 4.25
Irrigated pasture	7.75
Milo	10.70
Wheat	19.50
Cantaloupes	21.00
Onions	34.70
Potatoes	37.40

Current indications are that the cost of State Project water to the Mojave Water Agency will amount to about $58 per acre-foot. Since the payment capacities shown in Table 2 are well below this level, it is highly unlikely that any crop production would be economically feasible if the

farmer had to pay this much for water. The production of alfalfa and pasture, which presently account for about 90 percent of the crop acreage in the agency, would not even be profitable with water at $10 per acre-foot. It was assumed for the purposes of this analysis, that future agricultural water costs would approximate current levels and that the cost of imported water to the Agency would be recovered by increased urban water rates and by ad valorem taxation.

Even if water supplies were available for irrigation at reasonable costs, the inhibiting influence of late spring and early fall frosts, the low water holding capacity of most of the soils, and the likelihood of future urban encroachment on agricultural lands are expected to cause a gradual decline in irrigated farm acreage in the investigational area through 1990. All of the agricultural acreage during this period is expected to be located in the Mojave Water Agency; no agricultural development is anticipated in either the Morongo Valley Community Services District or the Yucca Valley-Joshua Tree territory. Table 3 shows the historical and projected acreages of irrigated crops in the area from 1960 to 1990.

TABLE 3

HISTORICAL AND PROJECTED ACREAGES OF IRRIGATED CROPS IN THE MOJAVE WATER AGENCY, 1960-1990

Crop type	1960	1970	1980	1990
Alfalfa	11,100	10,900	10,200	9,500
Irrigated pasture	2,900	2,700	2,300	2,000
Field crops	800	700	700	600
Grain and grain hay	400	300	300	300
Truck crops	200	200	300	400
Fruits and nuts	200	200	200	200
Total acreage[a]	15,600	15,000	14,000	13,000

a. Excludes fallow land and areas not actually devoted to crop production such as public roads, canals, etc.

While a moderate decline in agricultural acreage has been forecast for the area, it must be emphasized that a much sharper decline would occur if the cost of agricultural water were increased significantly. If, for example, the price of agricultural water were fixed at $25 per acre-foot, crop production would be limited to vegetables. Even though vegetables could be profitably produced at that water cost, late spring and early fall frosts would generally limit production to the summer months for all but a few crops. This means that the bulk of the crops would be placed on the market when prices are at their lowest. In addition, the number of crops that can be produced in the area annually is limited to one or two. Most growers of vegetables prefer areas where from three to five crops per year can be marketed. While some local growers may be expected to shift to vegetables under these circumstances, it is unlikely that there will be a major expansion of vegetable acreage in the area.

Livestock Production

An important livestock industry has existed throughout the subject area for many years and at the present time is more important in terms of dollar output than crop production. In 1956, the value of livestock output amounted to $7.7 million as compared with $2.8 million for all crop production. By 1963, according to estimates prepared by the University of California Agricultural Extension Service, the value of crops had risen to somewhat over $3.1 million, while livestock values, chiefly because of a drop in poultry and poultry products production, had declined to about $7.2 million. This latter figure, however, was still more than double the crop value. More than 80 percent of the total income from livestock products at that time was derived from the production of beef, sheep, hogs, and dairy cattle. A gradual increase in dairying is anticipated as population expands, but the number of sheep and beef cattle is expected to decrease with the projected decline in the volume of forage crops.

National Defense Activities

During the past two decades, national defense activities have become one of the most important elements in the economy of the Mojave Water Agency. At the present time, three major military installations are located within the boundaries of the Agency, providing a nucleus for research and development, testing, training, and supply. The three facilities are George Air Force Base near Victorville, the Marine Corps Supply Center near Barstow, and a portion of Edwards Air Force Base.

George Air Force Base is located on about 4,800 acres of land 100 miles northeast of Los Angeles and 5 miles west of Victorville. Established as a flying school during World War II, the base is currently used as an air defense installation and is manned by about 400 civilian

employees and 5,400 military personnel. An additional 7,600 acres of land in the northwestern part of the Mojave Water Agency's area is used by the base as a firing range.

The Marine Corps Supply Center at Barstow supplies, stores, and maintains military ground equipment for all Marine Corps units west of the Mississippi. The center carries on its operations at two locations -- Nebo and Yermo. These two sites, which are within 11 miles of each other, occupy approximately 3,840 acres of land and employ about 4,000 civilian and military personnel.

Edwards Air Force Base is located on the eastern edge of the Antelope Valley, 100 miles northeast of Los Angeles. During World War II, the base was used as a training field for fighter and bomber crews. In 1951, Edwards became one of the four centers of the Air Research and Development Command and since that time has been engaged largely in research and development projects of the Air Force Research Training Command, the National Aeronautics and Space Administration and other federal agencies. While about 10,000 civilian and military personnel are employed at the base, most of them live or are stationed in Los Angeles County, with the result that the base has had only a small effect on the economy of the investigational area.

Two other military installations which have imparted an element of economic strength to the region are located just beyond the northern boundaries of the Mojave Water Agency. These are the United States Naval Ordnance Test Station at China Lake and Fort Irwin north of Barstow. The Naval Ordnance Test Station, which is the Navy's largest ordnance research and development center, is manned by approximately 4,000 civilians and 1,200 military personnel. The station is located on two separate parcels

of land and has a gross area of 2,000 square miles. Fort Irwin, a training center for armored and tank units, occupies about 1,000 square miles of land and is manned by about 2,300 civilian and military personnel.

Because of the external character of their financial resources, the military installations within the area and to a lesser extent those outside the area have imparted an element of economic strength to the region. In future years, however, the changing nature of the nation's military needs will almost certainly affect the level of activity in these installations. Any forecast of the future level of defense activities must rest on several assumptions. The underlying assumptions employed in this analysis were that military expenditures will remain at high levels for an indefinite period, that the nation will continue to maintain its limited war capabilities, that the emphasis on military research will grow, and that missiles will replace manned aircraft as the major weapons in our defense arsenal.

At the present time, George Air Force Base and the Marine Corps Supply Depot are the only major military installations in the area. It seems reasonable to believe that George Air Force Base will eventually decline in importance as missiles are substituted for aircraft, although the decline may be moderated by an increase in flight training activities for ground support missions. There is a good likelihood, however, that the Marine Corps Supply Depot will operate at about the same level of employment in the future because of its importance as a ground force supply center. Current indications are, therefore, that future changes in the area's defense employment will be small and that defense activities will continue to contribute to its economic stability during the projection period covered by this report. Two major defense establishments outside the area

are playing a significant role in weapons development and may undergo future expansion. Because of their location, however, future employment changes at these bases are expected to have only a secondary effect on the economy of the investigational area.

Industrial and Commercial Activities

In addition to agriculture and defense activities, a number of other industries are making important contributions to the economy of the region. Among these industries are mining and cement production, railroad maintenance and repair, tourism and recreation, and trade and service activities.

As was mentioned previously, the area within the Mojave Water Agency was formerly one of the largest centers of mining in the State. At present, however, most of the mining is concerned with the extraction of limestone for cement. The cement industry is one of the area's oldest, a plant in the Victorville area having been constructed in the early 1900's. Today three major cement plants are located in the region, the Southwestern Portland Cement Company at Victorville, the Permanente Cement Company in the Cushenberry area of Lucerne Valley, and the Riverside Cement Company at Oro Grande. These plants have expanded to keep pace with the demand for building materials and have an annual capacity of 18 million barrels. This figure represents about one-third of the total capacity of California's cement industry.

Transportation has also played an important role in the development of the economy. In addition to being served by two major railroads and key interstate highways, the area is a major center for railroad maintenance and repair. The maintenance facilities are operated by the Santa Fe Railway

and are located in the City of Barstow, which is the hub of railroad activities in the area.

Since World War II, the desert has become increasingly attractive as a resort and recreational center and as a home for retired persons. The awakening of interest in the desert land was symbolized by the launching of Apple Valley in 1946 and Hesperia several years later. These promotional ventures have developed into planned communities of handsome desert-style homes, shopping centers, schools, golf courses, and other recreational facilities. The stir in desert land has extended into the Yucca Valley-Joshua Tree territory and the Morongo Valley where other homes and accommodations have been built. While retail trade and service activities in the investigational area are directed largely to the local market, many motels, service stations, and other facilities have been built to serve the needs of the tourist trade.

Possibilities for Economic Development

There are a number of factors which seem favorable to continued economic growth in the area under consideration, among them being climate, land availability and geographic location.

The area, first of all, has some definite climatic advantages for urban activities. It is well suited for industries requiring outdoor storage space because of its low humidity and low rainfall, while the year-round sunshine and clean air in the region should favor the development of recreational facilities and new homes for retired people who are expected to arrive in increasing numbers as metropolitan areas become more urbanized. High daytime temperatures are encountered during the summer but the growing use of air-conditioning equipment has moderated the effect of extreme summer heat.

Secondly, there are large quantities of land suitable for commercial, residential, and industrial use. For the most part, land prices are significantly below those in the Los Angeles metropolitan area.

Finally, the area is located within a relatively short distance of the Los Angeles metropolitan area and is connected to this great market by transcontinental rail lines and freeways. Victorville, for example, is about one hundred road miles from the center of Los Angeles, and Barstow about 125 miles. As population densities in the Los Angeles area increase, it is logical to believe that metropolitan growth will spread outward into adjacent areas where conditions for economic development are favorable.

It is unlikely, however, that all firms subject to these population pressures will choose to locate in the investigational area. This area will be competing for development with other areas peripheral to metropolitan Los Angeles which offer even more favorable conditions for future growth. Therefore, while the economy of the area is expected to expand considerably during the next few decades, the magnitude of growth will probably not be as great as the growth anticipated in other regions of Southern California.

Population

Historical Population Growth

Population in the investigational area expanded slowly until 1940 but has risen at a more rapid rate since that time, spurred by the establishment of major military installations during World War II and the general awakening of interest in the desert region during the postwar period. Today, as in the past, most of the area's population is concentrated in the Mojave Water Agency. In 1964, about 93 percent of the area's permanent residents

were living within the boundaries of that Agency as compared with 6 percent in the Yucca Valley-Joshua Tree territory and about 1 percent in the Morongo Valley Community Services District.

According to United States Census data, the population of the Mojave Water Agency amounted to about 55,300 in 1960. This represented a gain of 32,100 since 1950 and 46,400 since 1940. Estimates made by the San Bernardino County Planning Commission indicate that the total population of the Agency had grown to about 68,000 in July 1964 or 12,700 more than the 1960 total. Prior to 1940, there were only a few scattered settlers in the Yucca Valley-Joshua Tree territory and the Morongo Valley Community Services District. By 1964, however, about 4,700 persons were living within the territory and about 600 within the District.

Despite recent population gains, most of the investigational area is still sparsely populated in comparison with other portions of Southern California. In 1964, the area had an overall population density of only 17 persons per square mile as compared to about 1,400 in Orange County and 1,700 in Los Angeles County.

At the present time, about 90 percent of all the residents live and work near the 12 largest communities of the region. Barstow and Victorville are the main population centers. In 1940, Barstow had a population of about 2,000 persons, but by July 1964, its population had climbed to about 14,600, over 7 times the 1940 level. While the City of Victorville was not incorporated until 1962, data for the area now included within the City indicate that its population has almost tripled since 1950, climbing to 8,900 in 1964. Substantial population gains have also been registered by the communities of Apple Valley and Hesperia. Between 1950 and 1964, population in the former has increased from 1,300 to 6,800, while population in the latter has increased from 700 to 4,000.

Future Population Growth

A close relationship has existed and will continue to exist between population growth and economic development. People are attracted to areas offering new job opportunities, while new businesses are drawn to areas having an adequate labor supply. Valid population forecasts must consider this relationship as well as the relationships between adjacent areas, their resources, states of development, external and internal demographic pressures and other factors.

Working under a contract with the Department of Water Resources, the firm of Booz, Allen and Hamilton made an economic survey of the Antelope Valley-Mojave Basin which included separate population projections for the Mojave Water Agency and for adjacent portions of Kern and Los Angeles Counties that were based on the above criteria. The results of this survey were published in the Department's Bulletin No. 78, Appendix A, "Long Range Economic Potential of the Antelope Valley-Mojave River Basin". More recent population studies of this nature were also made by the Department for many subdivisions of Southern California and were published in its Bulletin No. 78, Appendix D, "Economic Demand for Imported Water". While no population projections were made for the Morongo Valley Community Services District or the Yucca Valley-Joshua Tree territory in Appendix D, specific projections were made for San Bernardino County, the coastal portion of the county, and the portion of the county within the Mojave Water Agency. The projections made for the coastal portion of the county and the Mojave Water Agency were deducted from the county-wide projections in order to arrive at preliminary population estimates for the Morongo Valley Community Services District, the Yucca Valley-Joshua Tree territory, and the remaining portion of the county. While the projections in Bulletin 78, Appendix D, served as the basis for

population forecasts for the area under investigation, the projections were updated to take into consideration the results of the 1960 census and the current County Planning Commission estimates not available during the Bulletin No. 78 studies. The population projections based on these studies and the estimated historical populations in the Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory are shown by ten-year intervals from 1920 to 1990 in Table 4.

TABLE 4

HISTORICAL AND PROJECTED POPULATIONS
1920-1990

Year	Population			
	Mojave Water Agency	Morongo Valley Community Services District	Yucca Valley-Joshua Tree Territory	Total Mojave Water Agency Service Area
		Historical[a]		
1920	4,200	b	b	4,200
1930	6,200	b	b	6,200
1940	8,900	b	b	8,900
1950	23,200	100	500	23,800
1960	55,300	500	2,600	58,400
1964	68,000	600	4,700	73,300
		Projected		
1970	90,000	1,400	8,600	100,000
1980	211,000	4,000	14,500	229,500
1990	393,000	8,500	24,500	426,000

a. Estimates for 1920 to 1960 based on U. S. Census data; 1964 estimates based on data obtained from San Bernardino County Planning Commission.
b. Data not available, but probably less than 100.

CHAPTER III. DEMAND FOR PROJECT WATER

The pattern and level of water use in the investigational area is expected to change significantly by 1990 under the impact of advancing urbanization. Large population increases destined for the Southern California area have been predicted to expand beyond the confines of the coastal plain and spread into the desert, bringing a proportional expansion in water requirements which must be met by an imported water supply.

During 1960, the total annual water requirements of the Mojave Water Agency amounted to about 48,000 acre-feet, excluding water requirements met by direct precipitation. Agricultural needs accounted for about 87 percent of the Agency's beneficial use, while urban demands accounted for the remaining 13 percent of the total. By 1990, however, expanding urban demands are expected to account for almost two-thirds of the Agency's beneficial water use. At the present time, all of the water supplied to consumers in the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory is used for urban purposes. Total urban water requirements in these two areas are expected to increase moderately from 1960 to 1990, but no agricultural demand is anticipated there during that period of time.

Future supplemental water requirements of the Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory were determined by taking the difference between local water supplies and estimates of the total urban and agricultural water requirements of each area. In July 1962, at the request of the Legislature, the Department of Water Resources initiated an investigation of the quantity and quality of local water resources along the Mojave River. This report utilizes the data obtained from this study during the 1962-63 fiscal year,

the first year of the proposed three-year investigation. It should be borne in mind, however, that estimates of the future need for supplemental water in the Mojave Water Agency, which encompasses most of the Mojave Desert area along the Mojave River, may have to be modified as more data from this investigation become available.

Only limited information is available on the local water resources of the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory. For this reason, estimates of the future need for imported water in these areas should be regarded as tentative.

Estimates of the total water requirements of each area were derived by applying appropriate unit values of urban and agricultural water use to the projections of population and irrigated acreage contained in Chapter II.

Present and Future Unit Water Use

Estimates of unit values of urban water use in the Mojave Water Agency were obtained from the Department's Bulletin No. 78, Appendix D. There were no comparable estimates made for the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory in that bulletin. It was assumed, however, that the unit values presented for the Mojave Water Agency could be used in estimating the future urban water requirements of the Yucca Valley-Joshua Tree territory and that the unit values of water use projected in Bulletin No. 78 for the northern portion of the Whitewater-Coachella area, which is adjacent to the Morongo Valley Community Services District, could be used in estimating future urban water requirements of that District. The estimated values of urban water use in the area under investigation are shown in Table 5. Unit values of consumptive use are presented rather than unit values of applied water use, since return flows in the area are generally available for reuse.

TABLE 5

ESTIMATED UNIT VALUES OF
CONSUMPTIVE URBAN WATER USE
1960-1990

Year	Gallons per capita per day		Acre-feet per capita per year	
	Mojave Water Agency and Yucca Valley-Joshua Tree Territory	Morongo Valley Community Services District	Mojave Water Agency and Yucca Valley Joshua Tree Territory	Morongo Valley Community Services District
1960	95	126	0.106	0.141
1970	101	130	.113	.146
1980	105	134	.118	.150
1990	107	139	.120	.155

The unit values of consumptive agricultural water use developed during the preparation of State Water Resources Board Bulletin No. 2, "Water Utilization and Requirements of California, 1955", and presented in the Department's Bulletin No. 78, Appendix D, were used in estimating agricultural water requirements within the Mojave Water Agency. These values are shown in Table 6.

TABLE 6

ESTIMATED ANNUAL UNIT VALUES OF
CONSUMPTIVE AGRICULTURAL WATER USE
In feet of depth

Crop	Unit values of consumptive water use
Alfalfa hay	2.8
Irrigated pasture	2.7
Deciduous fruits and nuts	2.1
Truck crops	1.5
Miscellaneous field crops	2.2
Hay and grain	0.9

Present and Future Water Use

Urban Water Use

Estimates of urban water use in the area under investigation were made by applying the appropriate estimates of per capita urban water use to projections of population for each decade of the study to 1990. Table 7 shows the resulting urban water requirements for the Mojave Water Agency, the Morongo Valley Community Services District, and the Yucca Valley-Joshua Tree territory.

TABLE 7

ESTIMATED URBAN WATER REQUIREMENTS
1960-1990

Area	Water requirements, acre-feet per year			
	1960	1970	1980	1990
Mojave Water Agency	5,900	10,200	24,900	47,200
Morongo Valley Community Services District	100	200	600	1,300
Yucca Valley-Joshua Tree Territory	300	1,000	1,700	3,000
Total	6,300	11,400	27,200	51,500

Agricultural Water Use

Estimates of agricultural water use in the Mojave Water Agency were made by applying the appropriate unit values of agricultural water use to projections of irrigated crop acreages in the Agency, contained in Chapter II. Table 8 shows the resulting agricultural water requirements in the Agency from 1960 to 1990. Unit water requirements for livestock are relatively small, and water costs are generally an insignificant portion of production costs. Therefore, water requirements were not computed for

livestock production in the area nor was any analysis made of water demands for livestock enterprises.

TABLE 8

ESTIMATED AGRICULTURAL WATER REQUIREMENTS[a]
1960-1990

Crop	Acre-feet			
	1960	1970	1980	1990
Alfalfa hay	31,100	30,500	28,600	26,600
Irrigated pasture	7,800	7,300	6,200	5,400
Miscellaneous field crops	1,700	1,500	1,500	1,300
Deciduous fruits and nuts	400	400	400	400
Hay and grain	400	300	300	300
Truck crops	300	300	400	600
Total	41,700	40,300	37,400	34,600

a. Data refer to the Mojave Water Agency. No demand for agricultural water exists or is anticipated in the Morongo Valley Community Services District or the Yucca Valley-Joshua Tree territory.

Local Water Supplies

Mojave Water Agency

The area encompassed by the Mojave Water Agency derives most of its local water supplies from the Mojave River and its respective ground water basins. The Mojave River is the chief drainage system of the northern slopes of the San Bernardino Mountains. Deep Creek, the east branch, and West Fork, the west branch, unite at the base of the mountains to form the headwaters of the Mojave River. At this point, which is known as the Forks, the flow of the river averages 61,600 acre-feet per year. From the Forks, the river flows generally north to Helendale, thence northeasterly to Barstow, and finally easterly into Soda Lake near the community of Baker.

Surface waters in the Mojave River usually percolate underground a short distance below the Forks, so that except during high flow periods, most of the river channel is dry. However, even during dry periods, ground water forced upward by natural geologic barriers produces perennial surface waters in the vicinity of Victorville and Afton.

Seven ground water basins within the Mojave Water Agency receive at least part of their water supply from the Mojave River. These basins are the Upper, Middle, and Lower Mojave Basins, which comprise the Mojave River Valley, and the Harper, Coyote, Caves Canyon, and Troy Basins.

The Upper Mojave Basin extends from the northern slopes of the San Bernardino and San Gabriel Mountains northward to Helendale and has an area of about 600 square miles. A bedrock barrier brings the Mojave River to the surface in the vicinity of Victorville where there is normally perennial flow.

The Middle Mojave Basin, which encompasses the Hinkley Valley, extends downstream from Helendale to Barstow, where a natural hydrologic barrier separates the Middle Basin from the Lower Basin. The Middle Basin is bounded on the north by the Harper Basin and has an area of about 400 square miles.

The Lower Mojave Basin, which has an area of about 300 square miles, extends eastward from Barstow to Soda Lake. The Basin is bounded on the north by the Coyote Basin, on the east by the Caves Canyon Basin, and on the south by the Troy Basin.

To aid in determining where future imported water supplies will be needed, the Department of Water Resources initiated an investigation of the quantity and quality of water supplies along the Mojave River at the request of the Legislature in July 1962. During the first year of the

three-year period of investigation, estimates were made of the available water supplies within the three basins comprising the Mojave River Valley and the Lucerne Basin which is outside the Mojave River drainage area but within the Mojave Water Agency. These estimates were published in the Department's "Progress Report of Mojave River Ground Water Basins Investigation for Fiscal Year 1962-63".

A preliminary analysis of the hydrology of the region, studied during the initial phase of the Mojave River Ground Water Basins' investigation, revealed that most of the water supplied to the basins is derived from surface runoff from the San Bernardino Mountains but that a significant amount is also derived from deep percolation of direct precipitation south of Hesperia. There is a minor amount of water imported to the region near Phelan. Subsurface flow is considered negligible.

Not all of the water received by the region is actually available for use. Some of the water is consumed by riparian native vegetation, some leaves the area as surface or subsurface outflow, and some is lost through evaporation. Outflow from the Mojave River Valley was measured at Afton, just outside the Mojave Water Agency. Ground water rises to the surface here and a recording stream gage has been maintained by the United States Geological Survey at that point.

During contract negotiations with the Mojave Water Agency, data were compiled and used that indicated that the mean annual inflow to the area from the Forks of the Mojave River was approximately 70,500 acre-feet per year. This estimate was based on stream gage records of Deep Creek and the Mojave River over an extended period of time.

Further analysis of these records disclosed that the runoff estimate exceeded the estimate obtained from more recent records of flow for similar conditions of vegetative cover and precipitation. However, because

of the need to arrive at an estimate of local water supplies in the Agency's area in order that a contract could be completed by June 30, 1963 (a significant date due to contractual provisions), it was necessary to postpone a detailed hydrologic study that would refine this estimate.

Hydrologic studies made since that time indicate that the average annual runoff of the Mojave River at the Forks for the base period 1936-37 through 1960-61 was 61,600 acre-feet. This change in the period of analysis resulted in a drop of 8,900 acre-feet in the Department's estimate of local water supplies available in the Agency's area from the estimate made at the time of contract execution. The Department's population projections for the Agency, contained herein, also represent a revision downward of the population projection made prior to contract execution. Thus, the Department's estimates of the Agency's future water requirements were also reduced.

After the revised estimates of local water supplies and future water requirements became available, the Agency expressed a desire to exercise its option for 6,800 acre-feet of additional water under the provisions of Article 8 of its water supply contract. An evaluation of this request indicated that the Agency had the financial ability to pay for this additional water, as will be shown in Chapter V, and that enlargement of the Agency's entitlement to accommodate the additional water would bring the relationship of local water supplies and future water requirements close to that which was believed to exist at the time of contract execution. Accordingly, the Agency's contract was amended on September 28, 1964, increasing its maximum annual entitlement from 44,000 to 50,800 acre-feet.

Table 9 presents the latest estimates of the annual values of water supply and disposal in the Mojave River Valley and the Lucerne Valley published in the Department's "Progress Report of Mojave River Ground Water Basins Investigation for Fiscal Year 1962-63".

TABLE 9

PRELIMINARY ESTIMATES OF AVERAGE ANNUAL WATER SUPPLY IN THE AREA COVERED BY THE MOJAVE RIVER GROUND WATER BASINS INVESTIGATION FOR THE BASE PERIOD 1936-37 THROUGH 1960-61
In acre-feet

Item	Mojave River Valley[a]	Lucerne Valley
Water Supply		
Runoff of desert mountain drainage areas	1,600	900
Runoff of Cushenberry Creek	-	100
Runoff of Mojave River at the Forks[b]	61,600	-
Imported water[c]	500	-
Subsurface inflow	100	-
Deep percolation of precipitation in the Upper Mojave Valley	6,000	-
Totals	69,800	1,000
Natural Water Disposal		
Riparian native vegetation	36,700	-
Subsurface outflow at Afton	5,000	-
Subsurface outflow to:		
Harper Basin	1,000	-
Coyote Basin	1,000	-
Troy Basin	500	-
Upper Mojave Basin	-	100
Evaporation from water supplies	1,500	-
Totals	45,700	100

a. Includes Upper, Middle, and Lower Mojave Basins.
b. The confluence of Deep Creek and the West Fork is called the Forks.
c. Infiltration galleries of the Sheep Creek Water Company on Sheep Creek, located south of State Highway 138, collect water that is imported by pipeline into the Upper Mojave Basin.

Estimates of local water supplies in the area covered by the Mojave River Ground Water Basins Investigation were made by subtracting the average water disposal in the area from the water supply received by the area. These estimates are presented in Table 10. As may be seen from the table, the safe yield of the local water supplies is estimated at 24,100 acre-feet in the Mojave River Valley and 900 acre-feet in the Lucerne Valley, bringing the total for these areas to 25,000 acre-feet. In addition to these supplies, some of the water presently consumed by phreatophytes could be salvaged if a planned drawdown of the Mojave River Ground Water Basins were instituted. The firm of Koebig and Koebig, consulting engineers for the Mojave Water Agency, has estimated that the amount of water salvaged by this method, together with pumping from neighboring underground basins such as Harper and Coyote, could approximate 10,000 acre-feet per year. Assuming that this additional 10,000 acre-feet of water will be made available after 1969, the local water supplies in the Mojave Water Agency would be 35,000 acre-feet, as shown in Table 10.

TABLE 10

ESTIMATED LOCAL WATER SUPPLIES IN THE AREA COVERED BY THE MOJAVE RIVER GROUND WATER BASINS INVESTIGATION
In acre-feet

Item	Mojave River Valley	Lucerne Valley
Average annual water supply	69,800	1,000
Less average natural water disposal	-45,700	- 100
Subtotal, present local water supplies	24,100	900
Plus, water expected to be salvaged from phreatophytes and obtained by pumping from ground water basins adjacent to Mojave River Valley after 1969	+10,000	0
Total local water supply after 1969	34,100	900

For the purposes of this analysis, the estimated local water supply available within the Mojave Water Agency will be considered to be the same as the local water supply established for the area shown in the preceding table. This assumption is reasonable because most of the Agency's water requirements now and in the projected future are expected to be concentrated in that portion of the Agency's area. Because of the millions of acre-feet of water in the Agency stored in basins outside the area covered by the table, it is anticipated that, for many years, the requirements in these outlying areas can be met from water stored within these basins.

Morongo Valley Community Services District

During the summer of 1964, the Department made a preliminary investigation of the local water supplies in the Morongo Valley in order to enable the Morongo Valley Community Services District to determine the desirability of joining one of the water service contractors in the area to obtain supplemental water from the State Water Project. The data obtained from this investigation are summarized in this section.

The basic water supply to Morongo Valley is derived from runoff entering the valley in Big and Little Morongo Creeks. Because of the absence of runoff and rainfall data for the watershed drained by these creeks, it was necessary to extrapolate data from the adjoining watersheds to obtain this information. Data obtained from a 76-year mean isohyetal map prepared by the U. S. Corps of Engineers indicated that a mean seasonal precipitation of 15 inches could be expected in this watershed. This estimate was substantiated in part by an isohyetal map in a United States Geological Survey publication entitled, "Hydrology of the San Bernardino and Eastern San Gabriel Mountains, California".

Because high-intensity storms of short duration are characteristic of the area and because Morongo Valley is steep and narrow (in traversing the Morongo Valley, Little Morongo Creek drops 100 feet in 2 miles and Big Morongo Creek drops 400 feet in 4 miles) it was estimated that average seasonal percolation would probably be on the order of 15 percent of the average seasonal runoff. Moreover, not all percolating waters can be recovered for beneficial use, because some of these waters leave the basin as surface or subsurface outflow or are consumed by phreatophytes and return to the atmosphere without contributing to the ground water supply.

Beginning with the estimates of precipitation, and utilizing the preceding estimates of runoff and percolation percentages, it was concluded that a safe yield of 100 acre-feet per year constituted a reasonable estimate, pending the availabillty of specific hydrologic and geologic data.

Yucca Valley-Joshua Tree Territory

The Yucca Valley watershed receives about 6 inches of rainfall annually, but only an estimated 150 acre-feet of water from this rainfall finds its way to the water table. There is no known subsurface inflow, and any subsurface outflow that may occur probably moves eastward toward Twentynine Palms. Presently, the average ground water level is 175 feet below the surface and dropping about 2 feet per year, indicating that the ground water basin is already overdrawn. While estimates of local water supplies in the area must be considered tentative until a more detailed study of the hydrology of the region has been completed, it was assumed for the purposes of this analysis, that the safe yield of the local ground water supply amounts to about 200 acre-feet per year.

Supplemental Water Requirements

Supplemental water requirements in the Mojave Water Agency's service area were determined by subtracting departmental projections of available local water supplies from projections of water needs. These requirements are presented in Table 11. As may be seen from the table, the total water requirements of the service area amounted to about 48,000 acre-feet in 1960, a figure nearly double the estimated safe yield of the available local water supplies. While it has been assumed that the safe yield of local water supplies will be augmented by the destruction of high water using plants along the Mojave River, the total water supplies expected to be available after this program is instituted would still be below the amounts needed to restore the balance between water supplies and water requirements in the area. The Agency's consulting engineers have investigated three alternative schemes for obtaining additional water through the conservation of runoff from Deep Creek, a tributary of the Mojave River. While an extensive review of this study has not been made, it appears that the annual per acre-foot costs of additional water from each of these schemes would exceed the cost of water from the State Water Project. There may be additional means of conserving water supplies in the investigational area, but more detailed studies will be required before the most satisfactory plan can be selected and its probable effect on future ground water levels assessed. Thus, it appears that the need for additional water can best be met through the importation of water from the State Water Project.

TABLE 11

PRESENT AND PROJECTED TOTAL AND
SUPPLEMENTAL WATER REQUIREMENTS
1960-1990

Item	1960	1970	1980	1990
Mojave Water Agency				
Urban water requirements	5,900	10,200	24,900	47,200
Agricultural water requirements	41,700	40,300	37,400	34,600
Total water requirements	47,600	50,500	62,300	81,800
Local water supplies	25,000	35,000	35,000	35,000
Supplemental water requirements	22,600	15,500	27,300	46,800
Morongo Valley Community Services District				
Urban water requirements	100	200	600	1,300
Agricultural water requirements	-	-	-	-
Total water requirements	100	200	600	1,300
Local water supplies	100	100	100	100
Supplemental water requirements	-	100	500	1,200
Yucca Valley-Joshua Tree Territory				
Urban water requirements	300	1,000	1,700	3,000
Agricultural water requirements	-	-	-	-
Total water requirements	300	1,000	1,700	3,000
Local water supplies	200	200	200	200
Supplemental water requirements	100	800	1,500	2,800
Mojave Water Agency Service Area				
Urban water requirements	6,300	11,400	27,200	51,500
Agricultural water requirements	41,700	40,300	37,400	34,600
Total water requirements	48,000	51,700	64,600	86,100
Local water supplies	25,300	35,300	35,300	35,300
Supplemental water requirements	22,700	16,400	29,300	50,800

Buildup of Demand for Project Water

From the supplemental water requirements which were available to the signators at the time of contract execution, a schedule of the demand for project water in the Mojave Water Agency's service area was constructed and incorporated into the Agency's water service contract with the State. Changes in the Department's local water supply estimates, and future population, caused an upward revision of the Agency's future water requirements after the contract was signed. The Agency's contract was amended to accommodate the additional supply of water needed to meet these requirements. Table 12 shows the annual amounts of water to be delivered to the Agency under the terms of the amended contract from the year of initial water delivery in 1972 to 1990, the year of maximum delivery.

TABLE 12

ANNUAL ENTITLEMENTS, MOJAVE WATER AGENCY
1972-1990
In acre-feet

Year	Entitlement in amended contract
1972	8,400
1973	10,700
1974	13,100
1975	15,400
1976	17,800
1977	20,200
1978	22,500
1979	24,900
1980	27,200
1981	29,600
1982	31,900
1983	34,300
1984	36,700
1985	39,000
1986	41,400
1987	43,700
1988	46,000
1989	48,500
1990	50,800

CHAPTER IV. COST OF WATER SERVICE FROM THE STATE WATER PROJECT

The cost of water service to the Mojave Water Agency and the Mojave Water Agency service area is dependent upon the Agency's allocated portion of construction, operation, and maintenance costs of the California Aqueduct, the cost accruing from the Delta Water Charge, and the cost of local conveyance systems. Construction of the State Water Project will be done by the State and will be financed with moneys from the California Water Fund and from the sale by the State of general obligation bonds authorized under the Water Resources Development Bond Act of 1959. Local conveyance facilities, on the other hand, will be constructed and financed by the Agency itself.

Under the standard contract for water service, the contracting agency undertakes an obligation to repay the State for its share of costs associated with water deliveries from the State Water Project. The allocation of transportation costs to the agency is made on the proportionate use of facilities concept, based on the relative size of maximum entitlement, the peaking capacity reserved in the aqueduct for the agency, and the distance from the Sacramento-San Joaquin Delta to the reach of the aqueduct wherein the agency's turnout structures are located. Article 22(c) of the water supply contract provides that the Delta Water Charge for each contractor shall be determined as the product of the entity's annual entitlement (for capital cost and minimum operation, maintenance, power, and replacement components) or actual deliveries (for the variable component) and the applicable unit Delta Water Charge or rate for each component. It also provides that through December 31, 1969, the unit Delta Water Charge will be $3.50 per acre-foot, without regard to components. The computation thereafter of the rate for each component of the charge is specified by a formula in Article 22(c).

State Water Project

The Mojave Water Agency's share of State Water Project costs can only be tentatively estimated at the present time, since the design of aqueduct facilities is not yet firmly established. However, based on information now known, cost allocations were made on the basis of a maximum annual entitlement of 50,800 acre-feet for the Agency and for the Mojave Water Agency service area which includes, in addition to the Agency, the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory.

Physical Features of the State Water Project

The Mojave Water Agency is relatively well situated with respect to the California Aqueduct, since the proposed route runs through the southwestern portion of the Agency in proximity to the areas of greatest potential development. Cedar Springs Reservoir is located just to the south of the Agency's southern boundary, providing a convenient site for emergency storage and regulatory service. The hydraulic grade line of the aqueduct is expected to be about 3,450 feet above sea level in the vicinity of the Agency's turnout structures, an elevation which would allow the Agency to serve nearly all of its developed area without pumping.

Cost of Facilities

The total allocated construction costs of the State Water Project to the Mojave Water Agency or the Mojave Water Agency service area are estimated at $15,769,000 for a maximum annual entitlement of 50,800 acre-feet. This would require a maximum annual repayment of principal and interest by the Agency of about $734,000. The annual capital payment would be lower than this amount in the years prior to 1978 and after 2013.

Operation and maintenance costs for the transportation facilities would be assessed in two ways. An annual minimum operation, power, and replacement charge would be assessed regardless of water deliveries and a variable operation, power and replacement charge would be levied depending on water actually delivered to the Mojave Water Agency. The maximum amount of these charges would be about $197,000 and $1,663,000 per year, respectively, in 1990. The final component of the Agency's annual cost for water deliveries would be the Delta Water Charge, based on the schedule of estimated annual water deliveries in the Agency's water service contract. At the time of this study, the Delta Water Charge was estimated to amount to $3.50 per acre-foot in the early years of the water service contract and then increase to $7.29 in 1970. Table 13 indicates the estimated annual component costs of water service from the State Water Project to the Mojave Water Agency service area for specific years during the period of buildup in water demand to 1990.

TABLE 13

ANNUAL CHARGES FOR WATER SERVICE FROM
THE STATE WATER PROJECT, 1965-1990

Year	Estimated annual water delivery, in acre-feet	Transportation charge				Total payment to State
		Capital cost component[a]	Minimum operation and maintenance[b]	Variable operation and maintenance[c]	Delta Water Charge	
1965	-	$ 35,900	$ -	$ -	$ -	$ 35,900
1972	8,400	709,600	191,400	169,000	61,200	1,131,200
1980	27,200	789,800	189,600	682,700	198,300	1,860,400
1990	50,800	790,400	197,300	1,663,700	370,300	3,021,700

a. Annual capital payment would remain at the maximum reached in 1990 to the year 2013 after which time it would continually decrease reaching zero in 2040.

b. Minimum operation, maintenance, and replacement charges are those necessary to maintain the system even though there are no water deliveries to the agency.

c. Variable operation, maintenance, and replacement charges are those associated with moving water to the agency.

Local Distribution Facilities

In order to distribute water imported through the State Water Project, it will be necessary for the Mojave Water Agency to provide a distribution system throughout its service area. An extensive engineering study will be required to determine the most economical design and alignment of such a system. This study will have to be made by the Agency or by the Agency together with other agencies involved. The Department, however, has made studies of a possible transmission system capable of serving the area under investigation. This system, which is described in the following paragraphs, is one that appears to be economical and feasible.

Construction Features of Local Distribution Facilities

The Mojave Water Agency has requested three turnouts from the East Branch Aqueduct and regulatory service from storage in Cedar Springs Reservoir. The local distribution system considered in this report would distribute water from these three turnouts to various parts of the Agency's area. From the easternmost turnout, a lateral would proceed easterly, turning out water for Hesperia, Apple Valley, Lucerne Valley, the Yucca Valley-Joshua Tree territory, and the Morongo Valley Community Services District. The gravity lateral serving Apple Valley would continue northwest into Victorville where it would connect with a lateral from the two other East Branch turnouts. From here, another gravity pipeline would convey water to Barstow, turning out water enroute as required. The main features of the local distribution system described in this paragraph are shown on Plate 1, "Location Map and Proposed Local Distribution System".

Cost of Local Distribution Facilities

An estimate of construction costs for the described local conveyance system was made for this report using the Mojave Water Agency service

area's maximum annual entitlement of 50,800 acre-feet as a basis for design. In preparing these cost estimates, the lateral designed to serve the Yucca Valley-Joshua Tree territory and the Morongo Valley Community Services District was sized to provide capacity for water deliveries to the Desert Water Agency and the Coachella Valley County Water District also, based on the assumption that these agencies would be interested in obtaining the economies accruing from a cost-sharing arrangement on a single large-capacity line serving the entire area. It was assumed that the Mojave Water Agency would not undertake the construction of a pipeline to the Yucca Valley-Joshua Tree territory and the Morongo Valley Community Services District without some form of cost-sharing agreement to alleviate the high cost of the project.

The estimated total construction costs of the local distribution system for the Mojave Water Agency service area are about $13,800,000. This estimate does not reflect the costs associated with turnout structures, local storage facilities, or water treatment facilities. The cost of water treatment would have to be borne by the Agency regardless of the source of imported water. Therefore, this cost was not included in cost figures directly attributable to contracting for State Project Water. Assuming a repayment period of 40 years at a 5 percent interest rate, the annual capital repayment requirement for this system would be $804,300. Maximum operation costs (occurring in 1990, under full delivery of maximum entitlement) would be $61,200 for a total annual cost in 1990 of $865,500.

The costs of water service have been translated into acre-foot costs for purposes of comparison with local unit water costs. These costs do not represent the actual average water cost from the State Water Project for any given year, but instead, are equivalent unit rates -- those costs that when applied to each acre-foot of entitlement during the repayment period would return all costs to the State with interest, at the project interest rate.

Table 14 shows the equivalent unit costs of various components of service from the State Water Project, including the costs associated with the local conveyance facilities. Deliveries of imported water to land holdings in excess of 160 acres were concluded to be relatively minor from the type of development expected in the Agency's area in the future, and were not accounted for in the analysis of water costs to the area.

TABLE 14

ESTIMATED UNIT COSTS OF WATER SERVICE FROM THE STATE WATER PROJECT AND LOCAL DISTRIBUTION FACILITIES

Components of cost	Equivalent unit rate, dollars per acre-foot
State Water Project	
Transportation Charge	
Capital cost component	$23.82
Minimum operation, maintenance, power and replacement component	5.15
Variable operation, maintenance, power, and replacement component	21.93
Total transportation charge	$50.90
Delta Water Charge	7.29
Total of cost components for State Water Project	$58.19
Local Conveyance Facilities	
Estimated operation, maintenance, and replacement component	$ 1.26
Estimated capital cost component	15.49
Total of cost components for local conveyance facilities	$16.75
Total of cost components for all water facilities	$74.94
Total, all operating components	$28.34

CHAPTER V. ECONOMIC JUSTIFICATION AND FINANCIAL CAPABILITY

Important and basic elements relative to the execution of a water supply contract between the State and the Mojave Water Agency are the economic justification of entering into such a contract and the financial capability of the Agency to meet terms of the contract. Economic justification proves the worth of the proposed water service, while financial capability indicates the ability of the Agency to repay the costs of water importation.

Economic Justification

A water development project can be considered economically justified if, as a minimum, the estimated benefits exceed the total economic costs and if each project purpose provides benefits at least equal to its allocated costs. In analyzing the economic justification of a water project for urban purposes, it has been shown that there will be a need for additional water supplies, that alternative sources of water would be more costly, that the costs of the project are not significantly greater than existing water costs, and that the area's economic development would be restricted without additional water. Water service from the State Water Project to the area under investigation is contemplated only for urban purposes; accordingly, the standards mentioned above were used as the bases for determining whether the project was economically justified.

The analysis presented in Chapter III demonstrated that the future economic development of the investigational area was dependent upon the receipt of imported water supplies. Under the forecasted conditions of future growth, the Mojave Water Agency would meet a significant share of its urban water demands with imported water by 1990. The present cost of

water production in the area was not determined, but the average cost to domestic users is presently about $78 per acre-foot. While the total cost of imported water to the ultimate consumer is not yet known, it is expected that this cost will not be unreasonably higher than local water costs, since the total cost of imported water to local distributors is expected to be about $75 per acre-foot. The Mojave Water Agency plans to act as a wholesaler of the imported water supply to other water agencies in its service area who would, in turn, distribute the water to the ultimate consumer. Since no substantial difference in the average cost of local and imported water to the ultimate consumer is anticipated, it is probable that economic development of the area would continue in the future under costs resulting from water importation and that benefits accruing to the area from water importation would exceed water costs. On the basis of these considerations, it may be concluded that water importation for urban purposes from the State Water Project is economically justified.

Financial Capability

To establish the financial capability of a public agency to undertake a particular project, it is necessary to show that the public credit of the agency is strong enough to reasonably support the day-to-day operating costs of the project and to repay any long-term debt and other fixed obligations which it will have to undertake in order to finance the project. In this instance, it is necessary to show that the Mojave Water Agency will not be unduly burdened by its overall debt and the aggregate amount of its unpaid fixed annual obligations during the project repayment period.

For the purposes of this report, an analysis was made of the financial ability of both the Mojave Water Agency and the Mojave Water Agency service area to meet the obligations incurred by the water supply

contract. As was mentioned previously, the Mojave Water Agency service area has been defined to include the area encompassed by the Mojave Water Agency and two adjacent territories -- the Morongo Valley Community Services District and the Yucca Valley-Joshua Tree territory. While the financial resources of these two territories have been examined separately, separate financial data on them has not been presented here.

Historical and Projected Assessed Valuations

A necessary part of a study of financial capability is to select a base that the area can use to determine its ability to repay its obligations. In this case, the obligation is to repay capital costs, interest, and operation, maintenance, and replacement costs of an imported water supply as well as the cost of local distribution and conveyance works. A principal base for determining repayment ability is the assessed valuation of the area.

As a result of increased population and economic activity as well as rising price levels, the assessed valuation of the area within the Mojave Water Agency during the fiscal year 1963-64, as estimated by the Department, was about $150 million while the assessed valuation of property within the service area was estimated at about $161 million. These valuations represent estimated market values of $572 million and $623 million, respectively. Table 15 shows the trend of assessed valuations in these two areas from 1958 to the present as estimated by the Department.

TABLE 15

ESTIMATED HISTORICAL ASSESSED VALUATIONS

Year	Mojave Water Agency		Mojave Water Agency Service Area	
	Assessed valuations	Percent increase over previous year	Assessed valuations	Percent increase over previous year
1958-59	$ 96,400,000	--	$102,600,000	--
1959-60	111,100,000	15.2	118,800,000	15.8
1960-61	125,800,000	13.2	134,800,000	13.5
1961-62	137,700,000	9.4	147,600,000	9.5
1962-63	143,200,000	4.0	153,600,000	4.1
1963-64	149,900,000	4.7	161,000,000	4.8

Assessed valuations of property in the Mojave Water Agency and the Mojave Water Agency service area will continue to increase in the next 30 years as the area's population and economic development continue to expand. For purposes of analyzing the financial capability of these areas to pay for service from the State Water Project, it was necessary to make projections of assessed valuations of the areas. These projections were conservatively made, based on the assumption that per capita assessed valuations would remain at their present levels through 1990. The assessed valuations projected for the Mojave Water Agency and the Mojave Water Agency service area are shown in Table 16.

TABLE 16

PRESENT AND PROJECTED
ESTIMATED ASSESSED VALUATIONS
1960-1990

Year	Mojave Water Agency			Mojave Water Agency Service Area		
	Population	Assessed value per capita	Assessed valuation (000's)	Population	Assessed value per capita	Assessed valuation (000's)
1964	65,300[a]	$2,296	$149,900	70,100[a]	$2,296	$161,000
1970	90,000	2,296	206,600	100,000	2,296	229,600
1980	211,000	2,296	484,500	229,500	2,296	526,900
1990	393,000	2,296	902,300	426,000	2,296	978,100

a. As of July 1963. Based on data obtained from San Bernardino County Planning Commission.

Historical and Projected Bonded Indebtedness

The Mojave Water Agency, as a political entity, has no bonded indebtedness at the present time. However, the area included within the Mojave Water Agency currently carries a bonded debt of $15,153,000, which is equal to 10.6 percent of the Agency's assessed valuation. Bonded indebtedness in the Mojave Water Agency service area is about $16,359,000 or 10.7 percent of the area's assessed valuation. School bonds account for the greatest portion of the debts in both areas, comprising about 85 percent of the total in each. Table 17 indicates the present bonded indebtedness for which property owners in the Mojave Water Agency and the Mojave Water Agency service area are responsible.

TABLE 17

PRESENT BONDED INDEBTEDNESS
BY TYPE OF DISTRICT[a]

Type of district	Mojave Water Agency	Mojave Water Agency Service Area
Schools	$12,875,454	$13,767,748
County	892,915	957,714
Water	719,000	719,000
Cities[b]	407,000	407,000
Parks	115,000	167,200
Community services	125,000	322,000
Fire protection	18,000	18,000
Flood control	260	260
Total	$15,152,629	$16,358,922

a. As of June 30, 1963.
b. City of Barstow only.

While assessed valuations and bonded indebtedness in the Mojave Water Agency and the Mojave Water Agency service area have increased substantially in the past six years, the ratio of bonded debt to assessed valuation has remained relatively stable during this period. Table 18 shows the relationship of bonded debt to assessed valuation in each area since 1958 as estimated by the Department.

TABLE 18

HISTORICAL BONDED INDEBTEDNESS

Year	Mojave Water Agency			Mojave Water Agency Service Area		
	Bonded debt (000's)	Assessed valuation (000's)	Debt as percent of valuation	Bonded debt (000's)	Assessed valuation (000's)	Debt as percent of valuation
1958	$ 8,750	$ 80,400	10.9	$ 8,953	$ 84,600	10.6
1959	9,980	96,400	10.4	10,214	102,600	9.9
1960	11,230	111,100	10.1	11,457	118,800	9.6
1961	12,091	125,800	9.6	12,965	134,800	9.6
1962	11,496	137,700	8.3	12,499	147,600	8.5
1963	15,153	143,200	10.6	16,359	153,600	10.6

Financing Future Obligations

The determination of financial capability requires an analysis of several interrelated factors including the amount of money required to pay the Agency's allocated share of costs, the probable necessary repayment schedule, present and future assessed valuations, tax rates prevalent in the area, current and future debt for public works other than those associated with the State Water Project, and the additional obligations that will be incurred in undertaking the importation of project water.

For this report, an investigation was made of the present financial condition of the Mojave Water Agency. The data gathered during this investigation are presented in detail in the appendix to this report. The data in the appendix do not attempt to measure the impact of proposed costs of water service on the Agency but may be used to obtain a picture of historical and current financial conditions within its boundaries.

Comparison with Assessed Valuations. In 1963, the ratio of bonded indebtedness to assessed valuations in the Mojave Water Agency and the Mojave Water Agency service area was slightly more than 10.5 percent. Although it is difficult to determine the extent to which these areas will incur bonded indebtedness in the future, it was assumed that the ratio of bonded debt to assessed valuations in each area would increase gradually to 11.0 percent in 1970, 11.5 percent in 1980, and 12.0 percent in 1990. These percentages were applied to the projected assessed valuations in the agency and the service area in order to estimate future debt other than obligations arising from the State Water Project. Table 19 shows the present and projected indebtedness in each area to 1990.

TABLE 19

PRESENT AND PROJECTED BONDED INDEBTEDNESS

Year	Mojave Water Agency		Mojave Water Agency Service Area	
	Bonded debt	Percent of assessed valuation	Bonded debt	Percent of assessed valuation
1963	$ 15,153,000	10.6	$ 16,359,000	10.7
1970	22,700,000	11.0	25,300,000	11.0
1980	55,700,000	11.5	60,600,000	11.5
1990	108,300,000	12.0	117,400,000	12.0

The debt ratios shown in the preceding table will be augmented by the additional obligations incurred by the Agency for service from the State Water Project. From the schedules of estimated allocated construction costs, costs of local conveyance facilities, and assessed valuations, the sum of the aggregate unpaid amount of the Agency's allocated share of the capital cost of the transportation facilities of the State Water Project in

any one year and the total debt outstanding on local conveyance facilities in the same year was calculated as a percentage of assessed valuation for the Mojave Water Agency and the Mojave Water Agency service area. These percentages are shown in Table 20. The debt ratios shown in this table are based on the assumption that the Coachella Valley County Water District and the Desert Water Agency would participate in the construction of a local distribution system capable of serving a portion of the Mojave Water Agency service area and that the Mojave Water Agency or the Mojave Water Agency service area would receive a maximum annual entitlement of 50,800 acre-feet. The effect of possible variations of this first assumption on the Mojave Water Agency's ability to pay for project water is discussed at the close of this chapter.

TABLE 20

SUMMARY OF CAPITAL REPAYMENT OBLIGATIONS
RESULTING FROM WATER SERVICE[a]

Year	Assessed valuation (000's)	Local conveyance facilities[b] Outstanding debt		Transportation facilities Aggregate unpaid capital costs		Total attributable to water service	
		Amount (000's)	Percent of assessed valuation	Amount (000's)	Percent of assessed valuation	Amount (000's)	Percent of assessed valuation
			Mojave Water Agency				
1963	$143,200	$ -	-	$ 629	0.4	$ 629	0.4
1972	262,200	12,778	4.9	14,208	5.4	26,986	10.3
1980	484,500	11,644	2.4	13,984	2.9	25,628	5.3
1990	902,300	9,437	1.0	11,840	1.3	21,277	2.3
			Mojave Water Agency Service Area				
1963	$153,600	$ -	-	$ 629	0.4	$ 629	0.4
1972	289,000	13,571	4.7	14,208	4.9	27,779	9.6
1980	526,900	12,371	2.3	13,984	2.6	26,355	4.9
1990	978,100	10,034	1.0	11,840	1.2	21,874	2.2

a. Debt ratios are based on a maximum annual entitlement of 50,800 acre-feet of imported water for each area.

b. Estimates relating to local distribution facilities are based on the assumption that the Coachella Valley County Water District and the Desert Water Agency would participate in the construction of these facilities.

In the year when the ratio of the sum of the outstanding debt and the aggregate unpaid transportation capital costs to assessed valuation is the highest, occurring in about 1971, the aggregate unpaid transportation capital costs for water service and total public debt would be about 21 percent of the assessed valuation of the Mojave Water Agency and 21 percent of the assessed valuation of the Mojave Water Agency service area. Thus, even at a maximum, the ratio of the sum of outstanding public debt and aggregate unpaid transportation capital costs to valuation in these two areas would appear to be reasonable. The ratio would decline continually throughout the project repayment period after 1971.

The projected ratios of debt and aggregate unpaid capital obligations in the areas under consideration were compared with those in other areas in similar circumstances. As a result of these comparisons, it was concluded that the Mojave Water Agency and the Mojave Water Agency service area would each have the financial capability of successful performance of their obligations under a water supply contract with the State for a maximum annual entitlement of 50,800 acre-feet of water delivery.

If the Mojave Water Agency were required to pay the entire cost of a local distribution system to serve only the area currently within its boundaries and not the Morongo Valley Community Services District or the Yucca Valley-Joshua Tree territory, the cost of such a system to the Mojave Water Agency would be somewhat higher than the cost of the local distribution system for the Agency's area described above. Assuming that this system were built and that future water deliveries were confined to the Mojave Water Agency, the projected ratios of debt to assessed valuation in the Mojave Water Agency would be somewhat higher than those previously presented in this chapter. However, these increases would in no way impair the Agency's ability to pay

for project water. It is considered highly unlikely that the Mojave Water Agency would pay the entire costs of a pipeline capable of serving both its area and the Yucca Valley-Joshua Tree territory and Morongo Valley Community Services District, as well, because of the high costs of the project. For this reason, no analysis was made of the Mojave Water Agency's ability to pay for project water under these conditions.

CHAPTER VI. CONCLUSIONS

Analysis of the data gathered and presented in this report has led to the following conclusions:

1. The Mojave Water Agency and the Mojave Water Agency service area have the potential for substantial population and economic growth and internal pressures suggest the probability of large increases in population and employment if sufficient water supplies are available.

2. The local water supplies available in the area under investigation are not sufficient to satisfy its future requirements; therefore, future growth will be seriously restricted unless a supplemental water supply is made available.

3. The Mojave Water Agency service area will have an economic demand for supplemental water supplies of approximately 50,800 acre-feet per year by the year 1990.

4. The Mojave Water Agency is empowered by its enabling legislation to enter into contracts with the State for the importation of water supplies through the State Water Project.

5. The financial position of the Mojave Water Agency and the Mojave Water Agency service area is such that the increase in fixed annual obligations and debt necessitated by the execution and performance of a water supply contract with the State for a maximum entitlement of 50,800 acre-feet per year from the State Water Project would not impose an unreasonable financial burden on these areas.

6. Financing the construction of necessary local distribution facilities, in addition to the fixed annual obligations that the Agency would incur under the contract with the State, would not increase the total ratio of debt and fixed annual obligations to assessed valuations in the Agency or in the Agency's service area beyond acceptable limits.

7. The Mojave Water Agency and the Mojave Water Agency service area each have the necessity, the economic justification, and the financial capability required to enter into a contract with the State of California for the service of water from the State Water Project.

APPENDIX A

CREDIT ANALYSIS OF THE MOJAVE WATER AGENCY

APPENDIX A

CREDIT ANALYSIS OF THE
MOJAVE WATER AGENCY

A. Statement of Debt of the Mojave Water Agency

1. Net Direct Debt (full faith and credit) June 30, 1963

   a. Bonds: none

   b. Floating debt: $15,000

   c. Total debt: $15,000

2. Special Obligations (not full faith and credit): none

3. Limitation on Debt

   a. Promissory notes: May be issued in amounts not exceeding two and one-half cents for each acre in the Agency. Maturity of notes shall not be greater than five years from date of issuance and the interest rate may not exceed six percent per annum.

   b. Bonds: Interest rate on bonds may not exceed seven percent per annum and maturity may not be greater than 40 years from date of issue.

   c. Applicable statutes: Chapter 2146, Statutes of 1959, Section 17.5 (promissory notes), and Section 19 (bonds).

4. Amount of Bonds Authorized but Unissued: none

5. Utilities Operated by the Agency (other than water service): none

B. Debt of Overlapping, Coterminous, and Underlying Political Units

Name and character of unit bearing bonded indebtedness	Net debt	Net debt assignable to the agency's area: Percent	Net debt assignable to the agency's area: Amount	Date of statement
San Bernardino County	$ 6,066,000	14.72	$ 892,915	6-30-1963
City of Barstow	407,000	100.00	407,000	"
Adelanto Community Services District	125,000	100.00	125,000	"
Apple Valley Fire District	18,000	100.00	18,000	"
San Bernardino County Flood Control District, Zone 2	2,603,000	.01	260	"
Barstow Park District	115,000	100.00	115,000	"
San Bernardino County Waterworks District No. 2	2,000	100.00	2,000	"
Victorville County Water District	395,000	100.00	395,000	"
Victorville County Water District, Improvement District No. 1	322,000	100.00	322,000	"
School Districts:				
Barstow Junior College	2,475,000	78.03	1,931,243	"
San Bernardino Valley Joint Union Junior College	220,000	.22	484	"
Victor Valley Junior College	500,000	96.49	482,450	"
Trona Unified Schools	634,000	2.12	13,441	"
Barstow Union High School District	3,449,000	78.03	2,691,255	"
Victor Valley Union High School District	3,680,000	96.49	3,550,832	"
Adelanto Elementary School District	129,000	100.00	129,000	"
Apple Valley Elementary School District	780,000	99.91	779,298	"
Barstow Union Elementary School District	1,032,000	100.00	1,032,000	"
Daggett Elementary School District	252,000	99.36	250,387	"
Helendale Elementary School District	30,000	100.00	30,000	"
Hesperia Elementary School District	373,000	100.00	373,000	"
Hinkley Union Elementary School District	388,000	100.00	388,000	"
Los Flores Elementary School District	32,000	61.45	19,664	"
Lucerne Valley Union School District	171,000	96.55	165,101	"
Newberry Elementary School District	5,000	84.41	4,221	"
Oro Grande Elementary School District	30,000	100.00	30,000	"

B. Debt of Overlapping, Coterminous, and Underlying Political Units (cont'd)

Name and character of unit bearing bonded indebtedness	Net debt	Net debt assignable to the agency's area: Percent	Net debt assignable to the agency's area: Amount	Date of statement
School Districts: (cont'd)				
Phelan Elementary School District	$ 20,000	99.95	$ 19,990	6-30-63
Victor Elementary School District	884,000	100.00	884,000	"
Yermo Elementary School	195,000	51.84	101,088	"
Total	$25,332,000		$15,152,629	

Name of school district bearing debt under State School Building Aid Program 1/	Net debt	Net debt assignable to the agency's area: Percent	Net debt assignable to the agency's area: Amount	Date of statement
Apple Valley Elementary School District	$ 177,908	99.91	$ 177,748	6-30-63
Barstow Union Elementary School District	1,684,950	100.00	1,684,950	"
Hesperia Elementary School District	89,455	100.00	89,455	"
Lucerne Valley Union School District	12,192	96.55	11,771	"
Victor Elementary School District	243,319	100.00	243,319	"
Total debt	$2,207,824		$2,207,243	

1/ This debt is in the form of direct loans from the State.

C. Summary of Full Faith and Credit Debt of the Water Agency and Other Political Entities

Type of debt	As of June 30th 1959	1960	1961	1962	1963
Net bonded debt	$ 0	$ 0	$ 0	$ 0	$ 0
Net floating debt	0	0	30,000	22,500	15,000
Overlapping, etc. debt	9,980,000	11,230,000	12,091,000	11,496,000	15,152,629
Total debt	$9,980,000	$11,230,000	$12,121,000	$11,518,500	$15,167,629

D. Default Record. There has been no default in the payment of principal or interest during the past twenty years, either by the water agency or by any overlapping, coterminous or underlying taxing district.

E. Assessed Valuations of Property in the Mojave Water Agency

1. Valuation by type of property	Valuation ($000)				
	1959-60	1960-61	1961-62	1962-63	1963-64
Secured property	$ 65,600	$ 77,500	$ 83,000	$ 85,600	$ 91,800
Unsecured property	5,100	6,600	6,000	6,200	6,500
Utilities	40,400	41,700	48,700	51,400	51,600
Total assessed value	$111,100	$125,800	$137,700	$143,200	$149,900

2. Assessment Ratio (proportion of market value): State Board of Equalization estimates of the district's assessment ratio are shown below for the years 1961-62, 1962-63, and 1963-64. Assessment ratios for 1959-60 and 1960-61 were estimated by using the mean of the following three years. Note that these ratios do not apply to public utilities, which are assumed to be assessed at 45 percent of market value.

1959-60 - 21.4%

1960-61 - 21.4%

1961-62 - 21.1%

1962-63 - 21.8%

1963-64 - 21.3%

3. Estimated Market Value of Property in the Agency

1959-60 - $420,200,000

1960-61 - $485,700,000

1961-62 - $530,000,000

1962-63 - $535,300,000

1963-64 - $576,200,000

4. Important Tax Exempt Property Within the Agency. The most important tax exempt properties in the area are the major military facilities owned by the U. S. Government. These consist of the Marine Corps Supply Center, comprising approximately 3,840 acres of land on two sites near Barstow, George Air Force Base, occupying 4,800 acres near Victorville, Cuddeback Lake Firing Range, occupying 7,600 acres in the northwest part of the agency's area, and a small portion of Edwards Air Force Base, 44,000 acres in extent, near the Los Angeles-San Bernardino County line.

5. Concentrations of Valuable Property Just Outside the Area. Three major military installations - the Naval Ordnance Test Station, Fort Irwin, and the major portion of Edwards Air Force Base - are located just beyond the outer rim of the Mojave Water Agency area. The Naval Ordnance Test Station at China Lake, which is the Navy's largest ordnance research and development center, lies to the north of the agency's boundaries about 155 miles from Los Angeles. Fort Irwin, which is used as a training center for armored and tank units, occupies 637,000 acres of land immediately to the north of the agency. Edwards Air Force Base has a total area of about 308,000 acres, of which 44,000 acres are located in the agency's area. Most of the work at this base is devoted to research and development programs of various federal agencies.

6. Ten Largest Taxpayers in the Area. The ten largest taxpayers in the agency in the approximate order of their assessed valuation are as follows:

California Electric Power Corporation

Pacific Gas and Electric Company

Atchison, Topeka, and Santa Fe Railway

Riverside Cement Company

California Interstate Telephone Company

Southwest Portland Cement Company

Southern California Gas Company

Southern Counties Gas Company

Union Pacific Railroad Company

Southern Pacific Company

These companies account for about one-third of the total county tax collections in the agency's area.

F. Property Tax Rates on Property in the Mojave Water Agency Area

Tax rate components	Weighted average tax rates in dollars per $100 assessed valuation				
	1959-60	1960-61	1961-62	1962-63	1963-64
County rate	$1.780	$1.795	$1.795	$1.970	$2.067
Cities 1/	.123	.134	.134	.134	.136
School districts	4.427	4.226	4.182	4.641	4.670
Water districts 2/	.031	.038	.032	.041	.035
Special districts 3/	.506	.573	.545	.545	.567
Mojave Water Agency 4/	-	-	.033	.034	.132
Total rate	$6.867	$6.766	$6.721	$7.365	$7.607

1/ Barstow only.
2/ Water district and community services district. Excludes tax rates for Mojave Water Agency which are shown below.
3/ Cemetery, fire, flood control, lighting, parks, and sanitation.
4/ Prior to 1963-64, tax rates for the agency were levied against land valuations only. In 1963-64, tax rates were levied against both land valuations and land and improvement valuations. These rates were converted into equivalent rates based on total assessed valuation.

2. Assessment Roll. Taxes for all districts are levied from the same assessment roll.

3. Legal Limits on Tax Rates (in dollars per $100 assessed valuation)

a.	Community services districts	$1.00	(Plus tax for bonds and other special assessments.)
b.	County library	0.30	
c.	Flood control district	0.15	(Plus taxes for bonds and other special assessments. No limit for drainage improvement.)
d.	Mojave Water Agency	0.45	(Tax on land only; plus tax of 0.10 on land and improvements for administration expenses and unlimited tax rate on land and improvements if tax on land does not raise the amount necessary to repay water supply contract obligations with the State.)
e.	Public cemetery districts	0.20	
f.	Sanitation districts	0.60	(Plus tax for bonds and other special assessments.)
g.	School districts	2.00	(Through junior college. Bonded debt subject to additional rates. Increased rates may be allowed under provisions of California Education Code, Sec. 20803.)

G. Record of Tax Collections on Property in the Mojave Water Agency Area

Fiscal year	Amount levied	Cash collections in year of levy		Uncollected at end of fiscal year	
		Amount	Percent	Amount	Percent
1962-63	$10,500,000	$9,996,000	95.2	$504,000	4.8
1961-62	9,300,000	9,002,400	96.8	297,600	3.2
1960-61	8,500,000	8,117,500	95.5	382,500	4.5
1959-60	7,600,000	7,303,600	96.1	296,400	3.9
1958-59	6,400,000	6,208,000	97.0	192,000	3.0

H. Receipts and Disbursements of the Mojave Water Agency

Income and expense	Fiscal year 1960-61	1961-62	1962-63
Cash, beginning of fiscal year	$ 0	$ 6,146.00	$16,319.52
Receipts			
Borrowings	30,000.00	0	0
Taxes	0	41,734.50	46,393.26
Miscellaneous receipts	33.05	20.00	10.00
Total cash plus receipts	30,033.05	47,900.50	62,722.78
Disbursements			
Operating expense	23,874.38	22,855.41	31,688.41
Principal and interest payments	12.67	8,725.57	8,344.16
Total disbursements	23,887.05	31,580.98	40,032.57
Cash, end of fiscal year	$ 6,146.00	$16,319.52	$22,690.21

I. Sinking Fund Operations. There are no sinking funds being operated by the agency at the present time.

J. Future Debt Service Requirements. None exist for the agency as an entity at the present time.

K. Management and Services.

1. Fiscal Policies. The agency has been in existence such a short time that no valid judgment can be made of its fiscal policies.
2. Services Performed by the Agency. The agency's primary function is to provide adequate supplies of water to all customers within its boundaries. Within recent months the agency has been actively engaged in the negotiation of a water supply contract with the State.

L. Economic Background

1. Land Area. The agency encompasses an area of 2,750,000 acres or 4,297 square miles in the northeastern part of San Bernardino County.

2. Population

1940	8,900
1950	23,200
1960	55,300

3. Employment[1/]

Industry group	Number employed April 1960
Mining	152
Construction	1,148
Manufacturing	1,753
Transportation, communication, and utilities	2,183
Wholesale and retail trade	2,908
Services	1,967
Government	4,071
Agriculture and other	2,053
Total	16,235

1/ Source: U. S. Census, 1960. Data represent jobs held by residents of the Mojave Water Agency. These jobs are both in and outside of the agency.

4. Agriculture. At the present time, about half of the 23,000 acres of agricultural land in the agency's area is devoted to alfalfa production. Most of the remaining acreage is devoted to irrigated pasture and miscellaneous field crops.

L. Economic Background (cont'd)

5. Industry

a. Principal activities

(1) Cement production

(2) Railroad car and track maintenance

(3) Recreation

(4) Defense testing, training, and supply

b. Major establishments in the area

(1) George Air Force Base

(2) Marine Corps Supply Center

(3) Atchison, Topeka and Santa Fe Railroad Repair Shops

(4) Riverside Cement Company

(5) Southwest Portland Cement Company

(6) Permanente Cement Company

6. Trade. Most of the workers employed in trade are engaged in supplying the basic needs of local residents. However, the number of persons passing through or stopping at recreational facilities in the area has been increasing in recent years. Their purchases have been responsible for a growing share of employment in retail activities.

7. Transportation. Railroad passenger and freight service is provided by the Santa Fe and Southern Pacific rail lines along a transcontinental route. Freight and passenger service is also provided by Greyhound and Continental Trailways and by several commercial truck lines. Three major East-West Highways, U. S. 66, 91, and 466, intersect with U. S. 395, one of the major access routes from the Mojave Desert to the Pacific northwest.

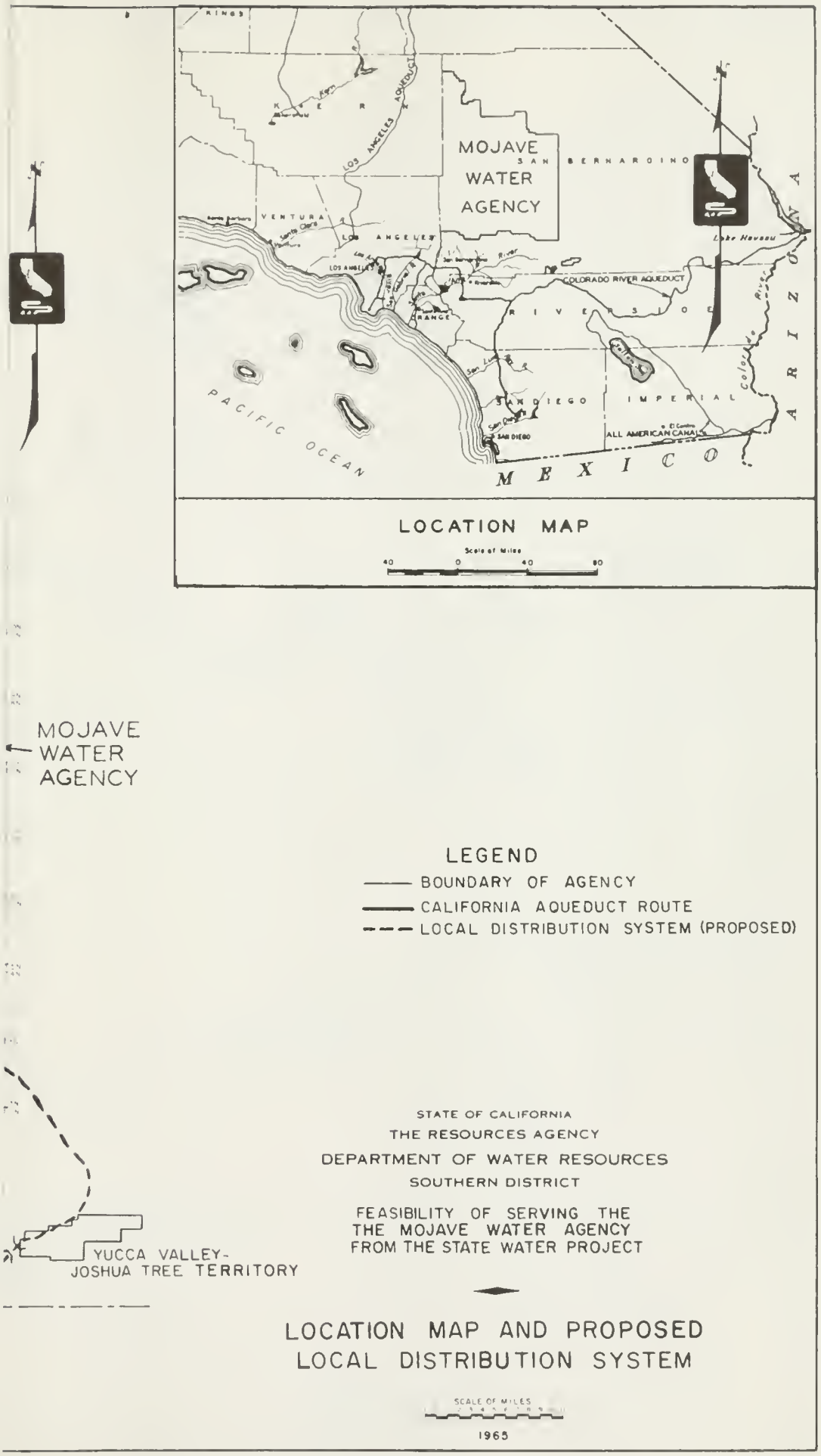
L. Economic Background (cont'd)

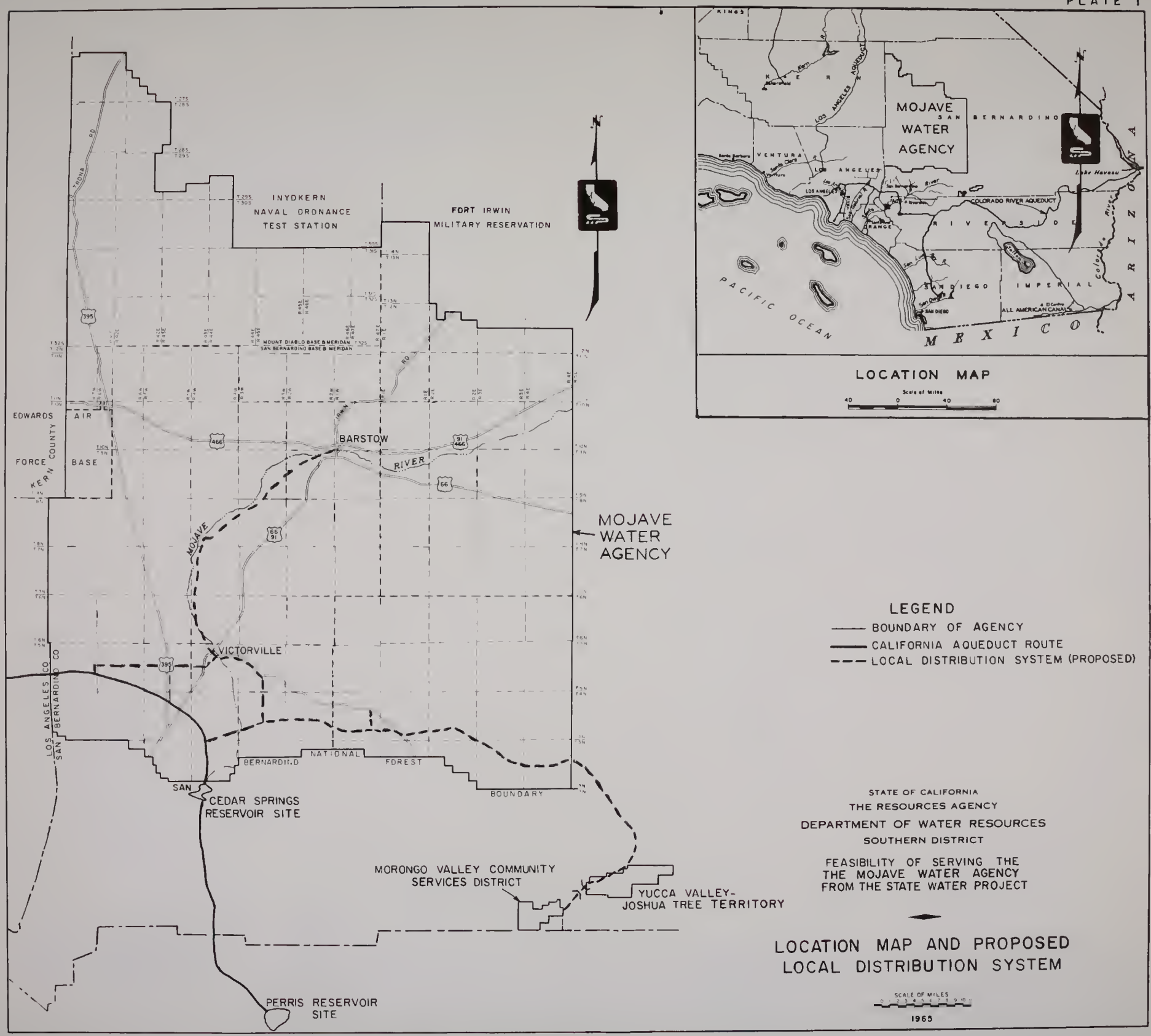
8. Natural Resources. The area's large deposits of limestone are processed by three major cement plants in the area. These plants account for a significant share of Southern California's total cement output. Deposits of tungsten and other minerals serve as a basis for other extractive activities in the region.

LOCATION MAP

Scale of Miles

40 0 40 80




INYDKERN
NAVAL DRONANCE
TEST STATION
FORT IRWIN
MILITARY RESERVATION
EDWARDS
AIR
FORCE
BASE
KERN COUNTY
BARSTOW
RIVER
MOJAVE
MOJAVE
WATER
AGENCY
VICTORVILLE
LOS ANGELES CO
SAN BERNARDINO CO
BERNARDINO
NATIONAL
FOREST
BOUNDARY
SAN
CEDAR SPRINGS
RESERVOIR SITE
MORONGO VALLEY COMMUNITY
SERVICES DISTRICT
YUCCA VALLEY-
JOSHUA TREE TERRITORY
PERRIS RESERVOIR
SITE
MOUNT DIABLO BASE & MERIDAN
SAN BERNARDINO BASE & MERIDAN
LOCATION MAP
MOJAVE
WATER
AGENCY
SAN BERNARDINO
VENTURA
LOS ANGELES
RIVERSIDE
SAN DIEGO
IMPERIAL
COLORADO RIVER AQUEDUCT
ALL AMERICAN CANAL
PACIFIC OCEAN
MEXICO
ARIZONA
LEGEND
BOUNDARY OF AGENCY
CALIFORNIA AQUEDUCT ROUTE
LOCAL DISTRIBUTION SYSTEM (PROPOSED)
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
FEASIBILITY OF SERVING THE
THE MOJAVE WATER AGENCY
FROM THE STATE WATER PROJECT
LOCATION MAP AND PROPOSED
LOCAL DISTRIBUTION SYSTEM
SCALE OF MILES
1965

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LEGEND

IRRIGATED AGRICULTURE

URBAN DEVELOPMENT

MILITARY RESERVATIONS

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

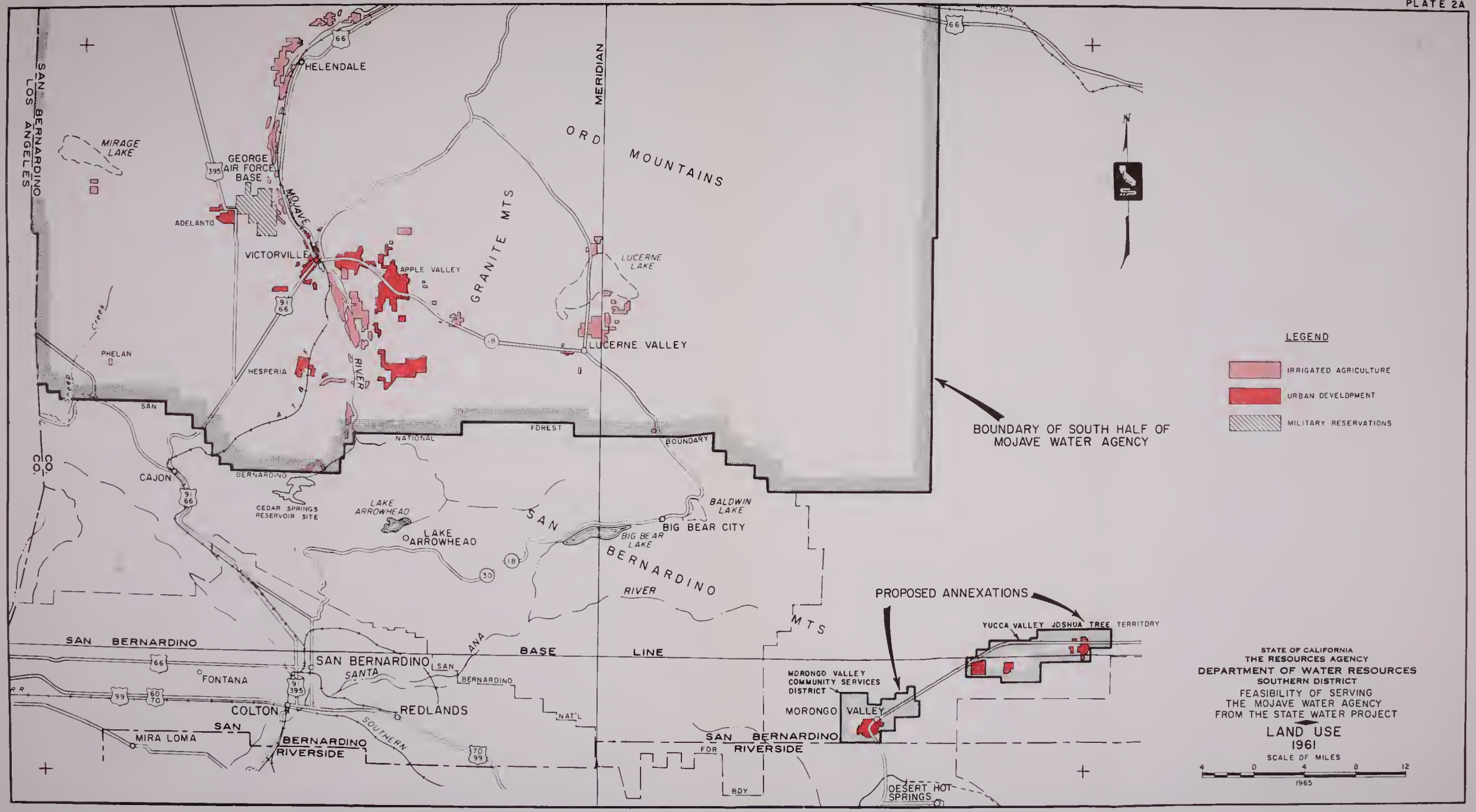
FEASIBILITY OF SERVING
THE MOJAVE WATER AGENCY
FROM THE STATE WATER PROJECT

LAND USE
1961

SCALE OF MILES

4 0 4 8 12

1965


SAN BERNARDINO CO.
LOS ANGELES CO.
HELENDALE
MIRAGE LAKE
GEORGE AIR FORCE BASE
ADELANTO
VICTORVILLE
APPLE VALLEY
MOJAVE RIVER
GRANITE MTS
ORD MOUNTAINS
MERIDIAN
LUCERNE LAKE
LUCERNE VALLEY
PHELAN
HESPERIA
CAJON
CEDAR SPRINGS RESERVOIR SITE
LAKE ARROWHEAD
BALDWIN LAKE
BIG BEAR CITY
BIG BEAR LAKE
SAN BERNARDINO RIVER
BOUNDARY OF SOUTH HALF OF MOJAVE WATER AGENCY
PROPOSED ANNEXATIONS
YUCCA VALLEY
JOSHUA TREE TERRITORY
MORONGO VALLEY COMMUNITY SERVICES DISTRICT
MORONGO VALLEY
SAN BERNARDINO
FONTANA
COLTON
REDLANDS
MIRA LOMA
RIVERSIDE
SANTA ANA RIVER
BASE LINE
DESERT HOT SPRINGS
LEGEND
IRRIGATED AGRICULTURE
URBAN DEVELOPMENT
MILITARY RESERVATIONS
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
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FEASIBILITY OF SERVING
THE MOJAVE WATER AGENCY
FROM THE STATE WATER PROJECT
LAND USE
1961
SCALE OF MILES
4 0 4 8 12
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LEGEND

IRRIGATED AGRICULTURE

URBAN DEVELOPMENT

MILITARY RESERVATIONS

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1961

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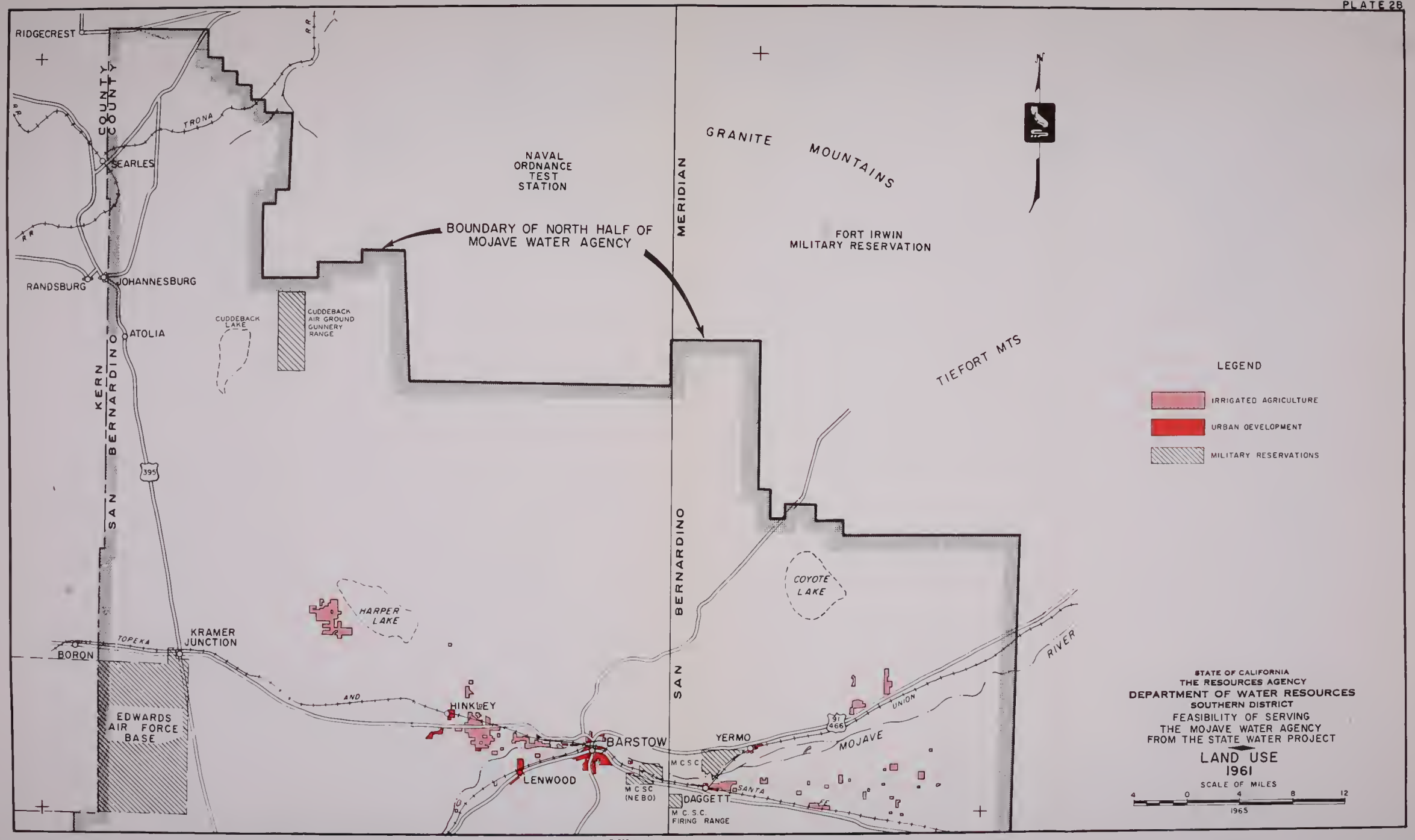
1965


RIDGECREST
KERN COUNTY
SAN BERNARDINO COUNTY
TRONA
SEARLES
RANDSBURG
JOHANNESBURG
ATOLIA
CUDDEBACK LAKE
CUDDEBACK AIR GROUND GUNNERY RANGE
NAVAL ORDNANCE TEST STATION
BOUNDARY OF NORTH HALF OF MOJAVE WATER AGENCY
SAN BERNARDINO MERIDIAN
GRANITE MOUNTAINS
FORT IRWIN MILITARY RESERVATION
TIEFORT MTS
COYOTE LAKE
HARPER LAKE
KRAMER JUNCTION
BORON
TOPEKA AND
EDWARDS AIR FORCE BASE
HINKLEY
LENWOOD
BARSTOW
M C S C (NEBO)
M C S C FIRING RANGE
DAGGETT
SANTA
YERMO
M C S C
UNION
MOJAVE
RIVER
395
91
466
LEGEND
IRRIGATED AGRICULTURE
URBAN DEVELOPMENT
MILITARY RESERVATIONS
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
FEASIBILITY OF SERVING
THE MOJAVE WATER AGENCY
FROM THE STATE WATER PROJECT
LAND USE
1961
SCALE OF MILES
4 0 4 8 12
1965
MATCH LINE FOR PLATE 2A