(AK)

[redacted]

[redacted]

3/99

INTERIM REPORT

Inland Basins Projects

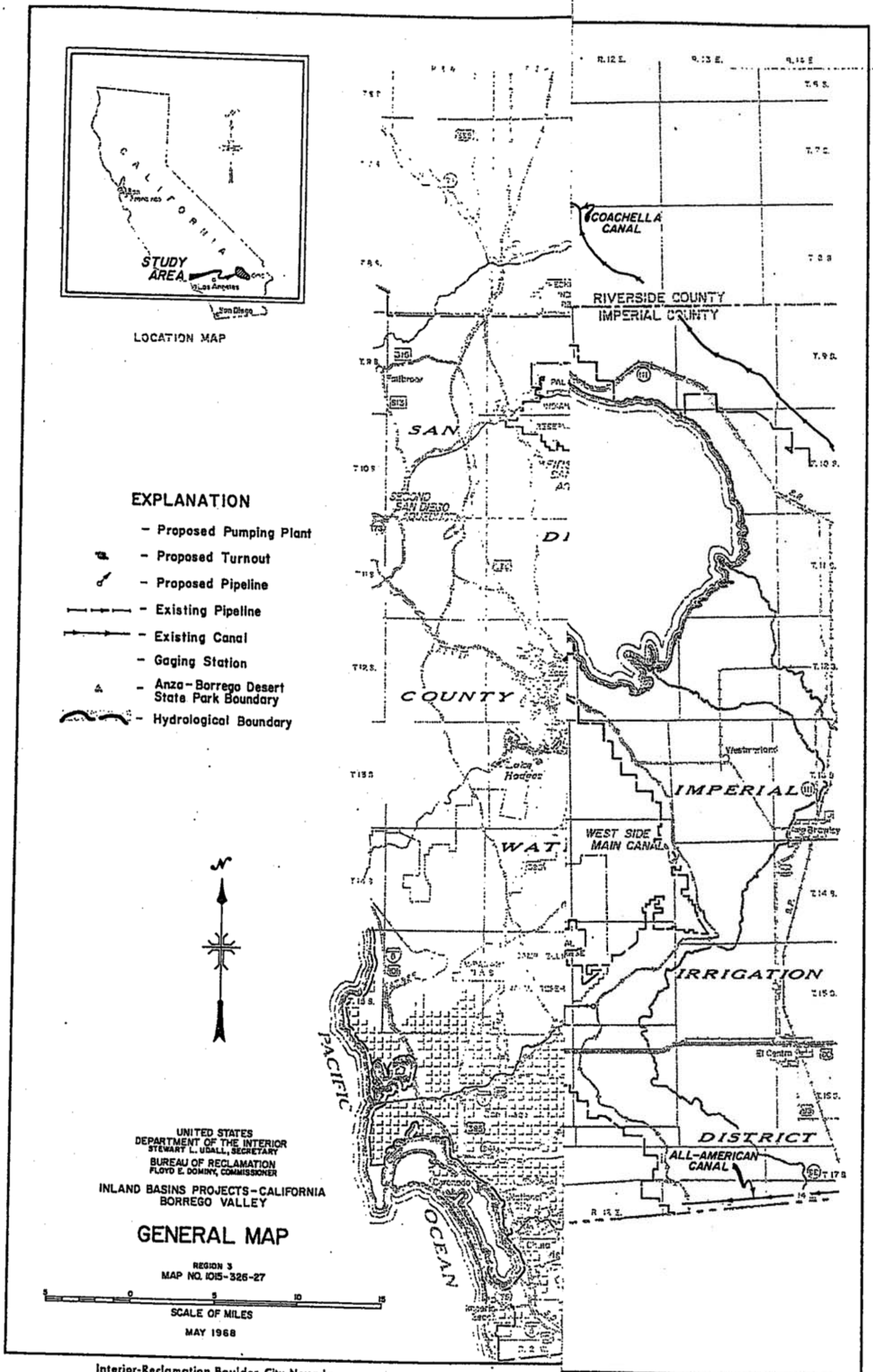
BORREGO VALLEY, CALIFORNIA

RECONNAISSANCE INVESTIGATIONS
JUNE 1968

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3

#1

15



Interior-Reclamation,Boulder City,Nevada

INTERIM REPORT
INLAND BASINS PROJECTS
BORREGO VALLEY
CALIFORNIA

RECONNAISSANCE INVESTIGATION

UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION
REGION 3

~~MAY~~ June 1968

Interior-Reclamation
Boulder City, Nevada

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS

LIST OF DRAWINGS

ADDENDUM

Memorandum of January 7, 1966, to Area Engineer, Southern California Development Office, Region 3, Bureau of Reclamation, from Regional Director, Region 2, Bureau of Outdoor Recreation, subject, "Recreation Reconnaissance of Inland Basins Projects - Borrego Valley, California."

PART I

TRANSMITTAL

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3
BOULDER CITY, NEVADA 89005

N REPLY
EFER TO:

To: Regional Director, Boulder City, Nevada

From: Area Engineer, San Bernardino, California

Subject: Interim Report, Inland Basins Projects, Borrego Valley, California

I. TRANSMITTAL

A. Introduction

The Inland Basins Projects is a reconnaissance investigation located in the Lahontan and Colorado River Basins of southwestern Nevada and southeastern California. The purpose of the Inland Basins investigation is to inventory the land and water resources, the present development, and the potential future needs of the inland basins. The total area to be inventoried is divided into separate study areas consisting of individual basins or groups of basins. An interim report is prepared for each study area when the studies of that area have been completed.

This interim report presents data pertaining to the historic, current and potential water development and requirements in the Borrego study area. For the purpose of this report, the Borrego study area is defined as those portions of Borrego Valley and Lower Borrego Valley situated in San Diego County, California, and excluded from the Anza-Borrego Desert State Park (General Map No. 1015-326-27, Frontispiece). The Clark Valley area is considered, in this report, as a part of the Borrego Valley portion of the study area, unless otherwise stated. Also shown on the General Map, by hydrological boundary, is the 960-square-mile area which provides the local water resources of the Borrego study area.

B. Authority for the Report

This report was prepared under the authority of the Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388, and Acts amendatory thereof or supplementary thereto).

C. Scope of the Investigation

This report is based on reconnaissance level surveys and studies. The data presented represent a broad range of information concerning area economics, population, political and physiographic geography, hydrology, soils and agriculture. When available, data of other Federal, State and local agencies were used.

D. Synopsis

From a small agricultural beginning, the economy of the Borrego study area has added strong recreational and tourist segments. New starts in the construction of tourist accommodations and residential, vacation and retirement homes have more than tripled in the past 10 years. Most of the present urban and agricultural development is near Borrego Springs in Borrego Valley. The Clark Valley area and Lower Borrego Valley are still largely uninhabited.

The prospects for continued urban growth in Borrego Valley are predicated primarily on (1) a favorable locale and climate; (2) the growing popularity of nearby tourist attractions; and (3) the increasing demands in southern California for outdoor recreational opportunities. The population in the study area is predicted to increase from 1,300 in 1965 to 30,000 by the year 2020. The projected municipal and industrial water requirements for the year 2020 are 17,000 acre-feet.

Of 39,190 acres of arable land in the study area, only 3,750 acres are developed for irrigation. Although the climate and soils are favorable for production of high-value specialty crops, local water resources would be inadequate to sustain any substantial increase in irrigated acreage. Maximum development of the potentially irrigable acreage would require an estimated 211,000 acre-feet per year.

Water supply for the present urban and agricultural development is obtained by utilizing local ground-water resources. Current extractions from ground water are estimated to be 28,300 acre-feet per year. The estimated 58-year average annual recharge of these basins is 40,000 acre-feet, but recharge over the 20-year period 1945-1964 averaged only 20,000 acre-feet per year. Moreover, about two-thirds of the recharge occurs in outlying basins where quality of ground water and specific yields of aquifers are largely unknown, while most of the ground-water withdrawals have been in the Borrego Springs area.

There is no known readily available source from which a supplemental water supply could be imported to the Borrego study area at this time. Possible sources from which a future import supply might be made available are: (1) future importations of water into southern California or the Lower Colorado River Basin; (2) desalinization of sea water (by exchange for a more accessible supply); (3) demineralization of waste waters which now discharge into the Salton Sea; or (4) annexation to a neighboring water district that might become entitled to water from one of the other sources.

All of these alternatives are predicated on the future possibility that Borrego could join in a cooperative plan involving a neighboring water district or some larger area. How soon such an opportunity might become available is unknown. Therefore, it will be necessary to carefully manage the local water resources in the Borrego study area until a supplemental supply can be provided. In this regard, none of the eight water companies or agencies now operating in the study area have sufficient responsibility to carry out a ground-water management and conservation program.

Two development plans based on the possible future sources of supplemental water are considered. Plan A would supply only the projected municipal and industrial water requirements, whereas Plan B would also provide the additional water required for maximum potential agricultural development. Cost estimates were prepared for conveyance systems from three different points outside the study area. Although the ultimate selection of a conveyance system would depend on the source, availability and cost of a supplemental supply, the plans presented are considered representative of possible future alternatives.

E. Conclusions

Conclusions based upon the findings of this report are:

1. A modest urban and agricultural base in the Borrego study area is provided a water supply by pumping local ground-water resources, which has resulted in declining ground-water levels in the areas of most rapid development.

2. There are 35,440 acres of undeveloped arable land in the Borrego study area for which there is no present water supply.

3. It is unlikely that the Borrego area could readily obtain a supplement supply of water from outside its boundaries in the near future. There are, however, several points outside the Borrego area from which it would appear feasible to transport a future supply of water to the valleys, if water at reasonable cost could be made available at these points.

4. Further development, management, and conservation of local ground water, as long as the supply and quality remain acceptable, would be the most logical source of water to meet the area's municipal and industrial growth needs until import water can be economically obtained. Organizational problems and water rights questions, that would be involved in further ground-water development, can best be resolved at the local level.

F. Recommendation

It is recommended that the study of the Borrego Valley development be reexamined when it appears that an import supply of water could be made available to the area.

G. Cooperation and Acknowledgments

Acknowledgment is given to individuals, businesses, and service agencies in Borrego Valley. The U. S. Geological Survey furnished some data on the ground-water conditions in the valleys. Recognition is also given to the Chamber of Commerce, Borrego Springs, California, the Borrego Springs Water Company, and California Department of Parks and Recreation, Division of Beaches and Parks for information furnished.

PART II

GENERAL DESCRIPTION OF THE AREA

II. GENERAL DESCRIPTION OF THE AREA

A. Location

The Borrego study area is located about 60 miles northeast of San Diego, California. The area is almost surrounded by mountains. The Santa Rosa Mountains lie to the north and east. To the west is situated a series of mountains of which the San Ysidro Mountains are the nearest. To the south the valley is bounded by the Vallecito Mountains. The location of the investigation area is shown on Map No. 1015-326-27.

B. Land Settlement History

It is believed that Pedro Fages was one of the first men to enter Borrego Valley. In 1772, he entered Coyote Canyon in pursuit of deserters from the Presidio of San Diego, California. In 1774, Juan Batista De Anza, explorer and colonizer of San Francisco, led an expedition of one hundred men and women through Borrego Valley. His route lay across the Imperial Valley, through Borrego Valley, and thence into the mountain regions by way of Coyote Creek. Under his leadership the expedition returned in safety to Mexico with stories of a land rich in resources. Accordingly, 18 months later a second expedition was led across the desert by De Anza. This expedition, consisting of 240 people and a large number of mules, horses and cattle, was the nucleus from which many of California's first settlements grew.

Vacationers who went each year to Palm Springs and vicinity ultimately discovered the scenic beauties of Borrego Valley and its surroundings. Their praises prompted officials to establish the Anza-Borrego Desert State Park in 1928.

C. Physical Features

The widest part of the valley between Anza-Borrego Desert State Park boundaries is nine miles. The length within the park boundaries is about 11 miles. Across these boundaries run the Coyote, Borrego Palm, and San Felipe Creeks. Coyote Creek originates in the Santa Rosa and San Ysidro Mountains and terminates at Borrego Sink. San Felipe Creek originates in Grapevine Canyon which receives runoff from the San Ysidro Mountains. Borrego Palm Creek originates in the San Ysidro Mountains and terminates in the Borrego Palms resort area. In Lower Borrego Valley there are a number of sand dune areas.

D. Climate

Borrego study area has variable rainfall, low humidity, high summer temperatures, abundant sunshine, relatively mild winters and occasional high winds. The frost-free period is about 285 days per year. Based on 20 years of records at Borrego Springs Station 3 North-Northeast (NNE), the average temperature is 70° F. and extremes range from a maximum of 121° F. to a minimum of 19° F. The prevailing wind direction is northwest.

The mean annual precipitation, based on the 20 years of record at Borrego Springs Station 3NNE, is 3.37 inches and at Ocotillo Wells Station, based on 21 years of record, is 2.90 inches. About 78 percent of the recorded precipitation falls during the winter months.

The surrounding mountains are cooler and receive more precipitation. Warner Springs, which is within five miles of the drainage divide, has an average annual precipitation of 16.16 inches, based on 58 years of records (1907-1964). However, the average for the 20-year period, 1945-1964, has been only 13.57 inches per year.

E. Vegetation

Native vegetation consists primarily of scrubby desert shrubs. Saltcedar has been planted for windbreaks but is rarely seen growing wild. Saltbush, mesquite, creosote bush, cholla, ocotillo, and agaves are common throughout the area. Picturesque desert flowers abound when spring rains follow a relatively moist winter.

F. Population

The major urban locale is at Borrego Springs where about 1,000 people reside permanently. Other small population centers exist at Borrego and at Ocotillo Wells.

At present there are an estimated 1,300 full-time residents in the study area. However, during the cooler months from October to April the population may vary from 2,000 to 8,000. Many families have recently built, or are in the process of building, vacation or retirement homes in Borrego Valley. Others rent homes or apartments by the week or month during the winter season.

Seasonal weekend vacationers to the Anza-Borrego Desert State Park frequently overflow into Borrego Valley and push the temporary population total even higher.

G. General Economy

The local economy, starting from a small agricultural base, has gradually added strong recreational and tourist segments. In recent years, the improved accessibility provided by paved roads into this once remote desert has greatly accelerated the construction of luxurious resort facilities, vacation and retirement homes, and tourist accommodations. Although the Anza-Borrego Desert State Park provides an attraction for tourists to Borrego Valley, the convenience of Borrego Valley accommodations within the vast reaches of the park contributes greatly to the increasing visitor use-days at the park. The proximity of Borrego Valley to the booming Salton Sea resort areas further enhances the valley's urban and recreational growth potential.

The construction industry is the largest single income producer and will likely remain so for several years as the valleys urban-recreation elements expand. Over 300 dwelling units for overnight, or longer, accommodations are available. Construction starts, particularly residential, have increased significantly in the past ten years. A new shopping center and high school will soon be completed.

Much of the existing urban development has been at the expense of agricultural lands that were already developed. This trend is expected to continue, but the 2,550 acres presently irrigated will probably not be appreciably diminished in the near future. There are 35,440 acres of undeveloped arable land susceptible of irrigation, and lands taken out of production can be easily replaced. In addition, there have been reports that a large-scale citrus planting will soon be attempted by one developer. If citrus production in the valley proves successful, it could provide an incentive for additional plantings of this high-value crop. A long growing season, an ever-expanding market in nearby coastal areas, an available supply of good quality ground water, and an increasing demand for citrus acreage in southern California are favorable factors that would tend to encourage the expansion of irrigated acreage in the future. The lack of rail transportation in the area, however, would tend to place Borrego Valley in a somewhat less favorable market position than competitive areas.

H. Local Water Agencies

There are several wholesale water distributors and water agencies within the boundaries of Borrego study area. A listing of water service organizations was obtained from data recorded with the California Public Utilities Commission and published in Bulletin No. 114 by the California Department of Water Resources. These organizations are listed in Table 1.

Table 1
WATER SERVICE AGENCIES 1/
Inland Basins Projects, California
Borrego Valley

Name of Water Agency	Type of Water Service Agency
Borrego Springs Water Company	Commercial
Borrego Springs Air Ranch Mutual Water and Improvement Company	Incorporated Mutual
Borrego Valley Water District	Public
Borrego Springs Park County Water District	Public
Golden Sand Mutual Water Company	Incorporated Mutual
Ocotillo Wells Mutual Water Company	Unverified Agency
Rancho Borrego Mutual Water Company	Incorporated Mutual
South Borrego Mutual	Unverified Agency

1/ Sources: "Directory of Water Service Agencies in California," Bulletin No. 114, State of California Department of Water Resources, June 1962, and "Property Valuations, Tax Rates, Useful Information for Taxpayers," County of San Diego, June 30, 1967.

PART III

PROBLEMS AND NEEDS OF THE AREA

III. PROBLEMS AND NEEDS OF THE AREA

A. Problems

The lack of an adequate water supply to permit full development of the land resources is the basic problem of the area. Water supplies for the present urban, recreational and agricultural activities are provided by utilizing ground-water resources deposited beneath the valley floor in previous years. There is not now an identifiable source from which a supplemental water supply could be imported. There is no present water shortage, and ground water in storage would be ample to sustain the projected growth in urban and recreational water requirements almost indefinitely. However, a substantial increase in the use of water for irrigation could rapidly deplete the available supply.

The greatest future water use would occur if all the arable lands were fully developed. Under these conditions, there would be a need to import about 211,000 acre-feet per year, assuming all water not required for plant consumptive use (evapotranspiration) would return to ground water by deep percolation. There are an estimated 3,500,000 acre-feet of water in storage in ground-water basins underlying Borrego. The 58-year average annual recharge to these basins is estimated to be 40,000 acre-feet. Therefore, if ground-water resources were devoted entirely to irrigation, the available supply could not long sustain the maximum level of agricultural development. In addition, deep percolation from irrigated areas and the recycling of this water could deteriorate the quality of water in the basins.

These potentially serious problems, still in the formative stage in Borrego, are not unique. Generally, they follow trends long familiar in the development of other areas of southern California and throughout the southwestern states. For agricultural and urban development to coexist in areas of limited local water resources, it has generally been necessary to import supplemental water supplies from outside the area. Unfortunately, there does not appear to be an economically feasible source of supplemental water that could be imported to the Borrego study area in the near future.

B. <u>Needs</u>

Corollary to the water supply problems is the overriding need to conserve and manage the existing water resources until a supplemental supply of water becomes available for importation. Only by careful management of available water supplies can the area be assured of optimum economic growth commensurate with the limitations of this vital resource.

The management and conservation of local resources are properly matters of local concern. However, in formulating a comprehensive action program to provide solutions to these problems, local interests will need information not presently available to them. There is need for a better understanding of the limitations of existing ground-water resources. A forthcoming U. S. Geological Survey report on the water resources of Borrego Valley will be an important contribution to this understanding. Continuing studies of possible sources of future supplemental water supplies and the probable costs of development and importation will also be needed.

Full development will ultimately require the importation of water. Some possible additional sources of supplemental supplies and probable conveyance costs from several points of diversion are considered in this report. These examples of possible future alternatives serve to emphasize the magnitude of the problems that will need to be solved. Without the future importation of water, the long-range growth in urban demands could probably be met only by limiting the development of agriculture.

PART IV

LAND CLASSIFICATION AND USE

IV. LAND CLASSIFICATION AND USE

A. Introduction

Land classification studies were made on a reconnaissance basis in 1964. Clark Valley was classified in 1966 and is included with Borrego Valley. The larger part of the Lower Borrego Valley is included in the West Mesa area of Imperial Valley for which a detailed land classification was completed by the Bureau of Reclamation in 1955.

B. Land Formation and Topography

Borrego Valley is part of the area known geologically as the Colorado Desert province. Most of the surrounding mountains and valleys were formed by faulting.

The sand dune areas of the Lower Borrego Valley appear to have evolved where winds blow predominantly from one direction. In the San Felipe Valley, in the same general area, are "spring-formed dunes." These dunes are formed where rising water allows vegetation to grow, which, in turn, accumulates sand until the dune becomes so high that water cannot rise through it and the spring is sealed.

The topography of the Lower Borrego Valley is generally precipitous and more broken than Borrego Valley. There has been more flash-flood erosion, as well as considerable wind erosion. Judging from the amount of fossil shells on the surface, the old beachline of Lake Coahuila extended across the area between Fish Creek Mountains and the Ocotillo Badlands. The soils are highly calcareous in places and appear to be partly cemented.

In general, the arable areas are topographically suited for irrigation development. The higher slopes should be terraced to avoid excessively long runs in the sandy soils. In the windblown area, protection from wind erosion would have to be provided before leveling is accomplished.

C. Soils

1. General. The soils of Borrego Valley are mostly alluvial, although there has been considerable sorting by wind and water in specific areas. Along the east side of the valley the wind has accounted for much of the size distribution of the sand. Fine sand, loamy sand, sandy loam, silt loam, and loam are the predominant surface soils. Most of the undeveloped land would fall in Class 3 because of water requirements and topography. The developed land appears to be mostly Class 2 due to water requirements, although on the north end of the developed area the water requirement would still leave the soils in Class 3 or 4. Some of the sandy soils have layers of micaceous silt loam and loam which tend to slow the infiltration rate and help hold moisture in the root zone.

2. Salinity and Alkalinity. Soils in Borrego Valley would require some leaching to grow the more sensitive plants. Apparently, water in some areas is somewhat saline, as an abandoned irrigation farm in the vicinity of Halfhill Lake shows evidence of salinity beyond that of the surrounding area. Another farm $1\frac{1}{2}$ miles to the northwest and about 50 feet higher in elevation is still in operation raising alfalfa and no evidence of alkalinity was found. It is possible the farm at the lower elevation was abandoned because of a failing water supply, as it was apparently irrigated from a large dugout instead of a well.

The 1955 West Mesa land classification, in its westerly extension, terminates at the Imperial-San Diego County Line and extends northerly to the old Lake Coahuila beachline. This classification found no salinity or alkalinity above the beachline. The most extensive area of saline soils found in the West Mesa area was below the beachline. Some evidence of sodium alkalinity was found, but apparently in scattered locations.

D. Drainage

Surface drainage appeared to be very good except for the Borrego Sink area within the 480-foot contour. This is the low point in the valley and all surface drainage collects here. Areas of salt encrustation are evident throughout the sink proper. This entire low area appears to be underlain by a layer of caliche or travertine. This layer apparently has holes or cracks in it, however, as numerous holes in the ground surface show evidence of rapid local infiltration which has carried the surface soil with it.

Internal drainage of soils in Borrego Valley is excellent.

E. Land Use

1. General. There is a total of 67,130 acres in Borrego Valley and 21,370 acres in Lower Borrego Valley to the edge of the Imperial West Mesa unit of the Imperial Irrigation District. Geological Survey quadrangle sheets were used and supplemented by field inspection to determine the present land use.

2. Agricultural Land Use. Development of agricultural land in Borrego Valley and Lower Borrego Valley has been on a very small scale. Of the 67,130 gross acres in Borrego Valley, only about 2,000 acres

were irrigated in 1965. Most of the irrigated acreage is in grape vineyards; however, some of the grape vineyards are being converted to citrus. There are small acreages of truck gardens and nurseries. An additional 26,320 acres of arable land in Borrego Valley could be developed if water were available. Lower Borrego Valley, excluding the Imperial West Mesa, has one alfalfa farm of about 550 acres, although 9,670 acres are considered arable.

Land in the Borrego study area is considered suitable for citrus development or for other specialty crops.

3. Special Land Use. There are a number of housing developments in Borrego Valley. There are also two country clubs, two air ranches (dude ranches with private airstrips), and a municipal airport. These urban areas total 4,550 acres. Lower Borrego Valley has urban areas totaling 200 acres.

F. Summary of Land Classification and Use

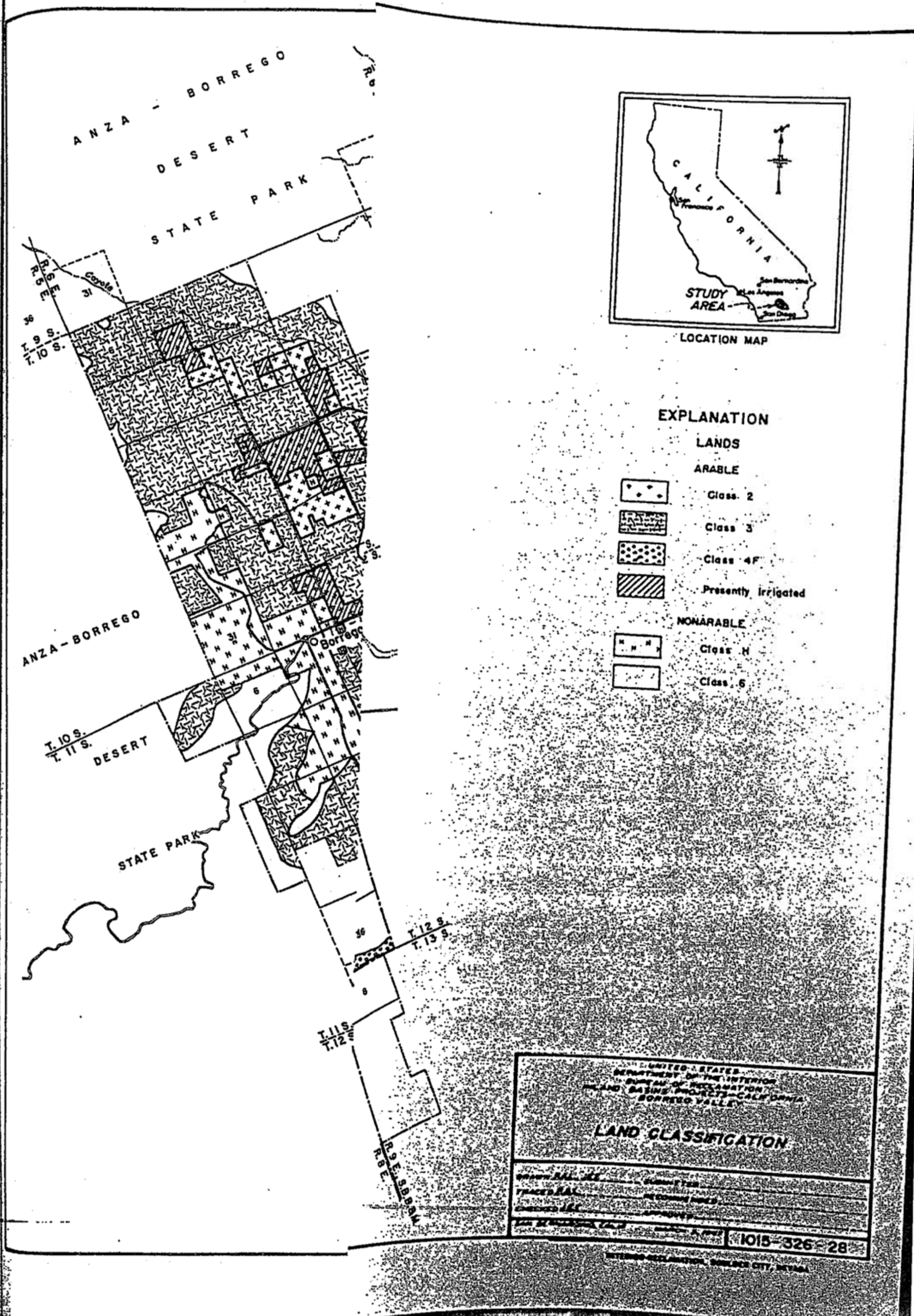
A summary of land classification and current use is shown in Table 2 and on Map No. 1015-326-28.

Table 2
LAND CLASSIFICATION AND USE SURVEY 1/
Inland Basins Projects, California
Borrego Valley

Unit: Acres

Land Use and Class	Borrego Valley: Excluding Clark Valley Area	Borrego Valley: Excluding Clark Valley Total	Borrego Valley: Clark Valley Area	Borrego Valley: Clark Valley Total	Borrego Valley: Total Borrego Valley Area	Borrego Valley: Total Borrego Valley Total	Lower Borrego Valley Area	Lower Borrego Valley Total	Area Totals	Total Area
Arable Land										
Irrigated										
Class 2 2/	1,200		0		1,200		0		1,200	
Class 2	2,000		0		2,000		0		2,000	
Class 3	0		0		0		550		550	
Total Irrigated		3,200		0		3,200		550		3,750
Nonirrigated										
Class 3	23,580		2,740		26,320		5,120		31,440	
Class 4F 3/	0		0		0		4,000		4,000	
Total Nonirrigated		23,580		2,740		26,320		9,120		35,440
Total Arable		26,780		2,740		29,520		9,670		39,190
Nonarable Land										
Class 6 Unused	25,600		7,460		33,060		11,500		44,560	
Land in Urban Use	4,550		0		4,550		200		4,750	
Total Nonarable		30,150		7,460		37,610		11,700		49,310
Total Land in Borrego Study Area		56,930		10,200		67,130		21,370		88,500

1/ Land classification and use based on 1964 reconnaissance survey (figures rounded).
2/ Idle and fallow land.
3/ Class 4 lands restricted to specialty crops, in this case citrus or deciduous.



ANZA - BORREGO
DESERT
STATE PARK
T. 9 S.
T. 10 S.
Borrego
ANZA-BORREGO
T. 10 S.
T. 11 S.
DESERT
STATE PARK
T. 12 S.
T. 13 S.
T. 11 S.
T. 12 S.
CALIFORNIA
STUDY AREA
San Francisco
San Bernardino
Los Angeles
San Diego
LOCATION MAP
EXPLANATION
LANDS
ARABLE
Class 2
Class 3
Class 4F
Presently irrigated
NONARABLE
Class H
Class 6
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
INLAND BASINS PROJECTS—CALIFORNIA
BORREGO VALLEY
LAND CLASSIFICATION
1015-326-28

PART V

WATER SUPPLY AND REQUIREMENTS

V. WATER SUPPLY AND REQUIREMENTS

A. Introduction

Within the watersheds in Borrego Valley there are three streams, Coyote Creek, Borrego Palm Creek, and San Felipe Creek. Some surface runoff is also attributable to canyon tributaries which discharge directly onto the valley floor. Some additional supply is produced from random desert storms that occur intermittently over the entire valley area.

Water requirements are based on estimated demands by municipal, industrial, and agricultural activities. There are also a few non-beneficial uses such as evaporation and phreatophyte consumption.

B. Surface Water Resources

1. Streams and Watersheds. Area streams originate in the Santa Rosa, San Ysidro, or Vallecito Mountains. The elevations of these mountains vary from 5070 to 8716 feet. The soil cover of the watersheds consists of residuum, colluvium, alluvium, and glacial drift from granitic rock sources. The native vegetation varies from desert shrub to subalpine forest and alpine prairie. Watersheds have generally well developed drainage systems.

2. Runoff Records. The U. S. Geological Survey operates and maintains gaging stations on Coyote, Borrego Palm, and San Felipe Creeks. The locations of these stations are tabulated in Table 3 and shown on Map No. 1015-326-27. Coyote Creek is the only perennial stream. The mean annual discharges on Coyote, Borrego Palm, and San Felipe Creeks are 1,630, 280 and 200 acre-feet per year, respectively.

Table 3
STREAM GAGING STATIONS
Inland Basins Projects, California
Borrego Valley

Stream	Gaging Station Name	Section	Town-ship	Range	Drainage Area (Sq. Mi.)	Period of Record	Maximum Flow (cfs)
Coyote Creek	Near Borrego Springs, California	23	9S	5E	144	14 yrs.	3,800 (July 28, 1951)
Borrego Palm Creek	Near Borrego Springs, California	26	10S	5E	21.8	14 yrs.	2,000 (Aug. 23, 1955)
San Felipe Creek	Near Julian, California	22	12S	5E	89.2	7 yrs.	45 (Dec. 30, 1965)

Although the normal flows in Coyote and Borrego Palm Creeks are small, there are occasional high flows. A flow of 3,800 cfs was recorded in Coyote Creek on July 28, 1951. A flow of 2,000 cfs was recorded in Borrego Palm Creek on August 23, 1955.

During the 7 years of record, the maximum recorded instantaneous flow in San Felipe Creek was 45 cfs on December 30, 1965. However, prior to this period of record, there have been times when high flood flows from San Felipe Creek reached portions of Lower Borrego Valley.

Most of the water from each of these streams either infiltrates into the ground-water basin or is evaporated.

3. Quality of Surface Water. Several surface water samples from Coyote Creek were checked for conductivity. The quality of water in this creek appears to vary with the surrounding vegetation and the quantity of water flowing. In areas of little vegetation the water may have as little as 250 parts per million (ppm) of total dissolved solids. Where vegetation is dense, the concentration during periods of low flow may reach 1,000 ppm.

No surface water samples were analyzed for Borrego Palm and San Felipe Creeks. However, the ground water in these basins appears to be of acceptable quality for domestic and irrigation uses.

C. Ground-water Resources

1. General. The quantity of water available for ground-water recharge was estimated for a 20-year period (1945-1964) and for a 58-year period (1907-1964) and is shown on Table 4.

Ground-water levels have declined an average of about 2 feet per year for the last 10 years. However, some wells in the study area

Table 4
ESTIMATED GROUND-WATER RECHARGE
Inland Basins Projects, California
Borrego Valley

Location	Drainage Area (Acres)	20-Year Average Annual Inflow--1945-1964 (Acre-Feet)	Long-Term Average Annual Inflow--1907-1964 (Acre-Feet)
Borrego Valley	208,500	6,000	11,000
Clark Valley	91,600	3,000	7,000
Lower Borrego Valley	343,500	11,000	22,000
Total	643,600	20,000	40,000

have dropped as much as 10 feet in 1 year. The average precipitation for the last 20 years has been less than the long-term average. Analyses of precipitation records indicate that, under long-term average conditions, the upper ground-water basin would be in approximate equilibrium.

2. Occurrence of Ground Water. The occurrence of ground water in the Borrego study area was based on data from existing wells, most of which are located in the northwest part of the study area. The limited data indicate that high yields might be attainable with proper well construction.

The following tabulation estimates present conditions of storage:

Ground-Water Basin	Recoverable Water in Storage (Acre-feet) 1/
Borrego Valley	1,300,000
Lower Borrego Valley	1,900,000
Collins Valleys	30,000
Clark Valley	300,000

Although additional data are needed to more adequately evaluate storage, quantities and quality of ground water, it appears there are about 3,500,000 acre-feet of recoverable water in storage within 200 feet below the water table. The present average depth to water ranges from 60 to 120 feet over most of the study area.

1/ Specific yield estimated to be 12 percent.

3. Ground-Water Quality. Water samples from the study area were collected and analyzed by the U. S. Geological Survey as part of an open file report. 1/

This report indicates a wide variation in ground-water quality, largely dependent upon the well location with respect to the contributing watershed. The best quality water, less than 500 ppm, is found adjacent to the northwestern boundary. This quality, however, deteriorates eastward toward the Borrego Sink area. The water quality in Lower Borrego Valley has total dissolved solids of about 1,200 ppm, but may be suitable for use on crops that are tolerant to salinity.

A map of the generalized ground-water quality and movement is shown on Map No. 1015-326-29.

4. Safe Yield. Although the safe yield of the watershed cannot be determined conclusively from the limited data available, the quantity of water which would be potential recharge under favorable infiltration and ground-water storage capacity conditions was evaluated from three sources.

a. Eakin Method. A method for estimating the average annual recharge from the average annual precipitation has been developed by T. E. Eakin and others 2/ for their studies in Nevada. Based on this method, the recharge is estimated as a percentage for

---

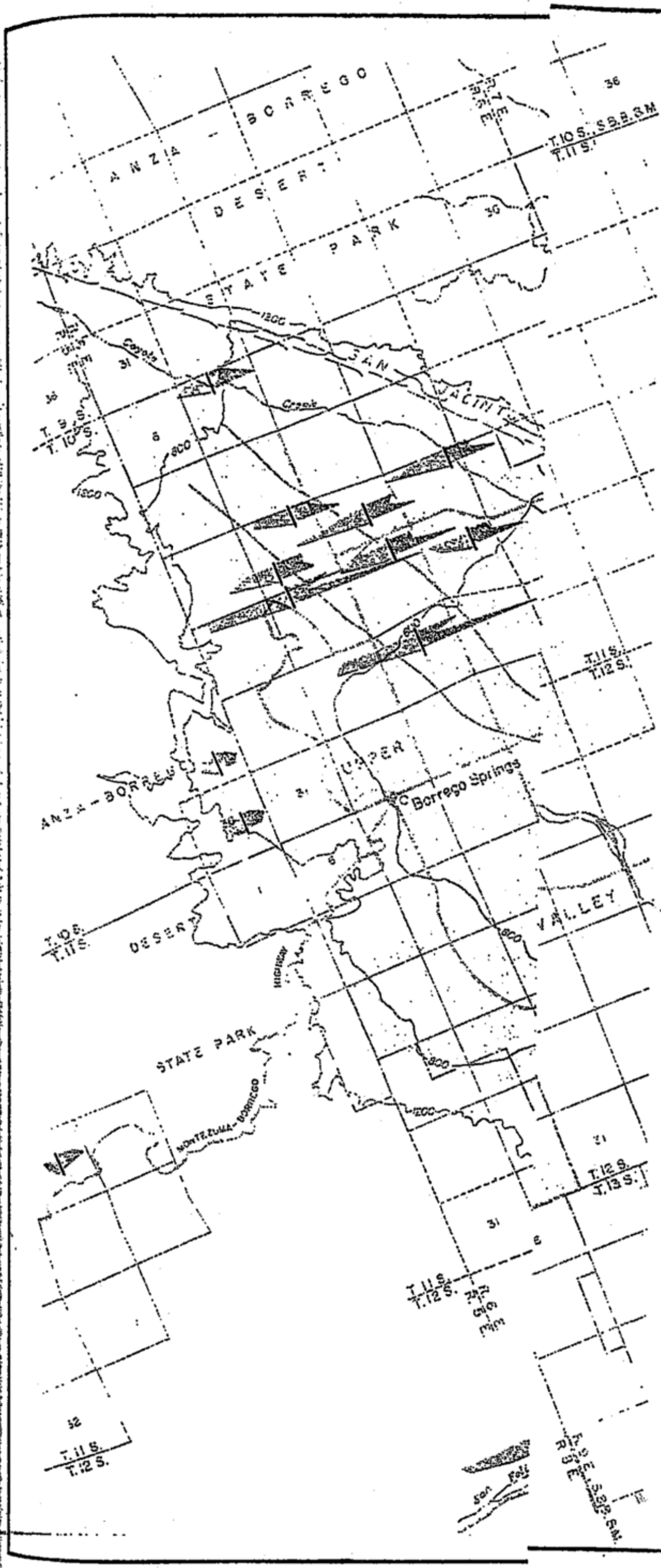
1/ "Data on Water Wells in Borrego, Ocotillo, San Felipe, and Vallecito Areas, Eastern San Diego County," U. S. Geological Survey, 1954.

2/ "Contributions to the Hydrology of Eastern Nevada, "State of Nevada, Office of the State Engineer, Water Resources Bulletin No. 12 by T. E. Eakin and Others, 1951, pp. 79-81.

each precipitation zone in the drainage area as follows: zone of less than 8 inches of precipitation, none; 8-to-12-inch zone, 3 percent; 12-to-15-inch zone, 7 percent; 15-to-20-inch zone, 15 percent; and above the 20-inch zone, 25 percent. Applying this method to a 30-year isohyetal map gives an average annual recharge of 18,300 acre-feet. There are several reasons to expect a higher recharge in the desert areas of southern California than in eastern Nevada: (1) the rainfall pattern is more seasonal in Borrego Valley with very little precipitation occurring in the summer months to sustain the native vegetation; (2) the evaporation rate is lower in Borrego Valley than it is in Nevada; and (3) the native vegetation is different in the two areas.

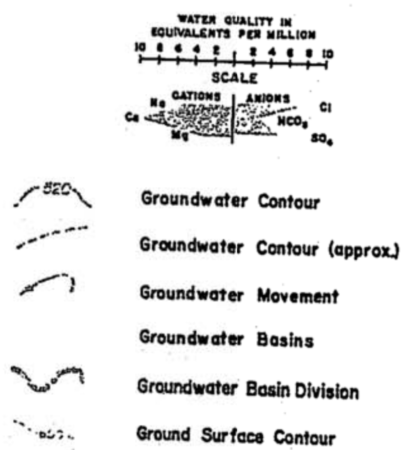
b. U. S. Geological Survey Surface Runoff. Geological Survey Professional Paper 486-B, "Precipitation, Runoff and Water Loss in the Lower Colorado River-Salton Sea Area," presents a map showing the estimated runoff from small tracts. This map indicates an average surface runoff from the mountains surrounding the study area of about 28,800 acre-feet per year. In addition to this inflow, most of which infiltrates to the subsurface before reaching the valley sinks, there should be subsurface inflow from hillside drainage plus the infiltration of precipitation directly on the valley floor, especially on the farmed acreage.

c. Department of Water Resources Coachella Investigation. The State of California Department of Water Resources, in Bulletin 108, "Coachella Valley Investigation," estimated the recharge to Coachella Valley, which shares common hydrologic boundaries with Borrego Valley, at 80,000 acre-feet per year. A comparison of the drainage areas and



LOCATION MAP

EXPLANATION



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
INLAND BASINS PROJECTS-CALIFORNIA
BORREGO VALLEY

GENERALIZED GROUNDWATER BASIN, QUALITY & MOVEMENT

DRAWN............ SUBMITTED............
TRACED............ RECOMMENDED............
CHECKED............ APPROVED
SAN BERNARDINO, CALIF. MARCH 3, 1967 1015-326-29

INTERIOR-RECLAMATION, BOULDER CITY, NEVADA weighted mean precipitation indicates that 40,000 acre-feet per year would be a reasonable estimate of recharge in Borrego Valley.

Also in Department of Water Resources Bulletin 108, the consumptive use by native vegetation was estimated to be 12 inches per year. Subtraction of this factor from the annual average of rainfall at Borrego Springs and Warner Springs yields an average of 50,000 acre-feet per year of water which would be available for ground-water recharge and surface runoff.

The 40,000 acre-feet per year recharge seems to be the most reasonable estimate considering the information available. However, future investigations should study the natural water supplies in more detail, including the effects of known but undefined faulting, localized ground-water overdraft, and water quality.

5. Reuse. The amount of reusable water will depend on the level and proportionate development of municipal, industrial, and agricultural activities. A large agricultural development could result in contamination and quality deterioration of underground water supplies, precluding the planned or incidental reuse of waste waters by deep percolation into ground-water storage.

Most agricultural developments within the study area will require water for leaching. A portion of the leaching water might be available for reuse so long as the concentration of salts remained low. The effect of the return flows upon the quality of the ground water and the potential for reuse will need to be determined in future studies.

It might be possible to reuse treated urban waste water for irrigating golf courses or in maintaining aquatic parks.

D. Water Requirements

1. Agricultural.

a. Present. Of 3,200 acres of land developed for irrigation in Borrego Valley, only 2,000 acres are presently irrigated. Current ground-water production to support this acreage is estimated to be 22,400 acre-feet per year. The 550 acres of irrigated alfalfa in the Lower Borrego Valley currently require the production of an estimated 3,900 acre-feet of ground water per year.

b. Future. There are about 35,440 acres of undeveloped arable land that could be irrigated if a water supply to sustain this development were available. Three conditions of future agricultural possibilities are considered in this report. For simplification, these are designated Conditions 1, 2 and 3.

(1) Condition 1. Without future importation of a dependable and economical water supply for irrigation, agricultural development in Borrego Valley may be restricted to about 1,000 acres or less by the year 2020. The retirement of agricultural lands to conserve the available water supplies would be essential to continued municipal and industrial growth.

The Lower Borrego Valley is not expected to have a population expansion comparable to Borrego Valley because of the prevalence of sand dunes and generally unsuitable topography. The ground-water supply in the Lower Valley is, however, adequate to permit a small increase in agricultural and urban land use.

The projected changes in irrigated agriculture and the resulting consumptive use of water, if there is no importation of additional water, are shown in Table 5. The actual pumpage required would be about 6.5 acre-feet per acre, but leaching water is considered to be returned to the ground-water basin.

(2) Condition 2. Maximum agricultural development must rely on an economical supply of imported water.

The quantity of water required is dependent, among other factors, on the quality of the water received. If the quality is similar to that of Colorado River water, then about 202,800 acre-feet per year would be required for consumptive use, leaching requirements, and normal on-farm losses. Of this total, about 71,500 acre-feet per year would be needed for leaching requirements.

The water requirements for Condition 2 are listed in Table 6.

(3) Condition 3. Agriculture in Borrego study area could have a moderate expansion, utilizing lesser amounts of imported water, without adversely affecting the water supplies for other uses. For example, the water requirements for a moderate increase in irrigated agriculture to 3,800 acres are shown in Table 7.

2. Municipal and Industrial.

a. Present. No major industry exists in Borrego study area. However, the rapidly expanding desert resort and the retirement community in Borrego Valley, with an increased demand for water during the tourist season, presently require approximately 2,000 acre-feet of water per year. The present urban water requirements are shown in Table 8.

Table 5
PROJECTED AGRICULTURAL REQUIREMENTS
CONDITION 1
Inland Basins Projects, California
Borrego Valley

Year	Borrego Valley		Lower Borrego Valley		Total	
	Acreage (Acres)	Water Requirement 1/ (Acre-Feet)	Acreage (Acres)	Water Requirement (Acre-Feet)	Acreage (Acres)	Water Requirement (Acre-Feet)
1970	1,500	9,750	500	3,250	2,000	13,000
1980	1,400	9,100	550	3,575	1,950	12,675
1990	1,300	8,450	600	3,900	1,900	12,350
2000	1,200	7,800	650	4,225	1,850	12,025
2010	1,100	7,150	700	4,550	1,800	11,700
2020	1,000	6,500	750	4,875	1,750	11,375

1/ Based on farm delivery requirement of 6.5 acre-feet per acre.

Table 7
PROJECTED AGRICULTURAL REQUIREMENTS
CONDITION 3
Inland Basins Projects, California
Borrego Valley

Year	Borrego Valley		Lower Borrego Valley		Total	
	Acreage (Acres)	Import Water Requirement 1/ (Acre-Feet)	Acreage (Acres)	Import Water Requirement (Acre-Feet)	Acreage (Acres)	Import Water Requirement (Acre-Feet)
1970	2,000	13,000	500	3,200	2,500	16,200
1980	2,100	13,600	600	3,900	2,700	17,500
1990	2,300	15,000	700	4,600	3,000	19,600
2000	2,500	16,200	800	5,200	3,300	21,400
2010	2,600	16,900	900	5,800	3,500	22,700
2020	2,700	17,600	1,000	6,500	3,700	24,100

1/ Based on an import farm delivery requirement of 6.5 acre-feet per acre rounded to nearest 100 acre-feet of use on an annual basis.

Table 8
PRESENT AND PROJECTED MUNICIPAL, INDUSTRIAL
AND RECREATIONAL WATER REQUIREMENTS 1/
Inland Basins Projects, California
Borrego Valley

Year	Permanent Population	Unit Water Requirement (Acre-Feet Per Person)	Total Water Requirements		
			Permanent Population (Acre-Feet)	Visitors and Recreation 2/ (Acre-Feet)	Total (Acre-Feet)
1965	1,300	0.300	390	1,610	2,000
1970	2,000	0.305	610	2,050	2,660
1980	5,500	0.314	1,730	2,970	4,700
1990	10,000	0.323	3,230	3,870	7,100
2000	16,000	0.332	5,310	4,790	10,100
2010	22,500	0.341	7,670	5,650	13,320
2020	30,000	0.350	10,500	6,500	17,000

1/ This table includes requirements for Borrego and Lower Borrego Valleys.

2/ Visitor and recreational requirements are computed as follows:

2 golf courses at 150 acres each and requirement of 5 acre-feet per acre = 1,500 acre-feet. Visitor days to Anza-Borrego State Park at 400,000, equivalent to a permanent population of 1,100 at 0.1 acre-foot per person.

1965: 1,500 acre-feet
110 acre-feet
1,610 acre-feet

The year 2020 consists of 8 golf courses at 150 acres each and 5 acre-feet per acre with an estimated visitor days of 1,000,000, equivalent to a permanent population = 2,800 at 0.2 acre-foot per person.

2020: 6,000 acre-feet
500 acre-feet
6,500 acre-feet

b. Future. The Borrego study area is expected to continue the rapid urban growth it has experienced in the last 10 years. The area is in an advantageous location to attract tourists as well as vacationists from San Diego, Los Angeles, and other coastal areas. An increase in the population of southern California would probably result in an increase of visitors to Anza-Borrego Desert Park and of the permanent residents in Borrego Valley. Future water supplies to sustain this growth could come from either imported water or ground water.

The per capita use rates used to determine the municipal and industrial requirements were based on a comparison of the per capita use rates in San Diego and Imperial Counties. More emphasis was given to Imperial County's per capita use rates because of its proximity to Borrego study area and because of the similarity of climatic conditions. Per capita use rates for golf courses and other recreational uses were computed separately from the municipal and industrial uses. Projected municipal and industrial water requirements are shown in Table 8.

3. Recreation.

a. Present. The Anza-Borrego Desert State Park now has an average of 400,000 visitor-days per year. The 400,000 visitor-days are equivalent to a permanent population of approximately 1,100 and require about 100 acre-feet of water per year. Also, within Borrego Valley, most of the motels have swimming pools and there are two golf courses available for public use. The two courses, encompassing about 300 acres of land, require about 1,500 acre-feet of water per year.

b. Future. The projected increase in future population of nearby coastal areas should cause an increased demand for recreational opportunities. This would mean an increase in golf courses, swimming pools, and other related water using recreational activities. The park visitors plus the part-time residents will require additional public, private, and commercial facilities.

The projected recreational water requirements are shown in Table 8.

4. Water Rights. There have been no known court decisions on adjudication of waters within the Borrego study area. The surface flows are mostly intermittent, and in the past no storage of local runoff was necessary; however, the surface flows do replenish the ground-water supply. There are some appropriative water rights on Coyote, Borrego Palm, and San Felipe Creeks. Historically, wells have been freely installed and withdrawals have not been regulated.

E. Possible Sources of Future Water Supply

It has been recognized by the California Department of Water Resources and Federal and local governments that the California State Water Project would satisfy the needs of southern California only until about 1990, after which time there will be a need for an additional supply of supplemental water. Borrego might be able to participate along with other desert areas of southeastern California in plans to import water for demands beyond 1990.

At present, there is no readily available source from which a supplemental water supply could be imported. The area does not have a contract for water from the California State Water Project and it is unlikely that import water could be obtained from the Colorado River under current conditions. Possible sources for future importation of water are discussed in the following paragraphs:

1. Desalinization. Water could be furnished through exchange by a desalting plant at a location on the Pacific Coast. It would be advantageous to locate a plant near San Diego, California. The water converted at this plant could be used in San Diego and vicinity, and water diverted from San Diego County Water Authority's aqueduct at a turnout near Escondido could be made available to Borrego through a system of pipelines. This exchange would require the approval and cooperation of the San Diego County Water Authority.

It has been suggested that desalted water could be imported from the Gulf of California to inland areas, including southern California. No studies are available to indicate the physical or financial capabilities of importing water from this source.

There might be other locations on the Pacific Coast where it would be advantageous to locate desalting plants, but the physical and financial capabilities would need to be taken into consideration.

2. Demineralization. Each year over 1,000,000 acre-feet of brackish water flows from Coachella and Imperial Valleys into the Salton Sea. It would be possible to place an electrodialysis demineralizing plant within one of these areas to intercept some of this brackish water. This plant could convert brackish waters from approximately 3,000 ppm to 500 ppm of total dissolved solids. However, records indicate there are undesirable concentrations of boron in this water that probably would not be removed by this process. Moreover, the

processing and exportation of water now flowing into the Salton Sea would further aggravate the existing salinity and water-level problems at the Sea. Therefore, this plan does not offer an acceptable prospect for future study.

3. Regional Water Plans. Borrego might be able to participate with other desert areas of southeastern California in a regional plan to obtain a future supplemental supply.

a. Northern California. Studies are being made concurrently in Region 2 and Region 3 of the Bureau of Reclamation to explore possible sources of water to meet southern California water requirements beyond 1990. One possible future source of water might be from the planned terminus of the federally proposed east side facilities of California' Central Valley Project near Bakersfield, California. Enlargement of these facilities beyond the design requirements of the Central Valley area, to include capacity for water service to southern California, would be required. The alignment for this plan would probably parallel the State's California Aqueduct and would require some additional regulatory storage.

b. Other sources. There are other studies being made by Federal, State, and private agencies to obtain water to meet the needs beyond 1990 for southern California and to supplement the flows of the Lower Colorado River.

If one or more of these studies prove fruitful, Borrego might be able to obtain entitlement to a supplemental water supply at some time in the future.

4. <u>Annexation</u>. Borrego study area is in a location whereby it would be possible to annex to nearby water districts. These districts are the Imperial Irrigation District, the Coachella Valley County Water District, and the San Diego County Water Authority. However, none of these districts appear to have surplus water at the present time.

It is also possible that under some future water plan, one of these districts could convey a supply of water destined for Borrego through its systems, for a charge per acre-foot of water.

PART VI

PLANS AND ESTIMATES

VI. PLANS AND ESTIMATES

A. Introduction

Since the source of a future supplemental water supply is not known at this time, it was decided to examine development plans utilizing several different conveyance systems believed to be representative of alternatives that may be available in the future. Plan A would import water to meet the projected municipal and industrial demands. Plan B would import water to meet the year 2020 projected municipal, industrial, and agricultural demands.

B. Plan of Development

Each plan of development would require a terminal reservoir for peaking of municipal and industrial water supplies. This peaking reservoir (proposed Borrego Springs Reservoir) could be located near Borrego Springs Community Center. The reservoir would have sufficient capacity to allow the pipeline to flow at a uniform rate of 25 cfs and would also provide the emergency storage required, in case of a pipeline outage, to meet a one-week demand during the maximum monthly demand period.

The Borrego Springs Dam site is located in fan deposits at the base of a barren granitic outcrop. These deposits range from silty sand to angular granitic fragments of gravel size.

Seepage control measures would be required over most of the reservoir area. Hard rock at the far end of the reservoir has been extensively folded and faulted; however, this is above the estimated normal water surface.

The faulting throughout the Borrego study area is very recent. Its topographic expression is apparent even in the loosely consolidated fan deposits.

All construction materials required for the earth dam embankment would be locally available within a reasonable hauling distance. Pertinent data for the Borrego Springs Reservoir are shown in Table 9.

1. Development Plan A. Development Plan A would require the importation of sufficient water to meet the projected requirements for municipal and industrial uses. The possible sources of water are discussed in Part V. The three representative points of diversions that were considered are located on the San Diego Aqueduct, in Coachella Valley near Oasis, and on the Imperial Irrigation District's Westside Main Canal of the All-American Canal System. Designs and cost estimates have been prepared for a conveyance system from each of the three delivery points of import water.

a. Escondido-Borrego Route. Import water from the San Diego Aqueduct would be diverted through a pipeline called the Escondido-Borrego Route to the proposed Borrego Springs Reservoir. About 15 miles of this route would be founded on poorly consolidated alluvial and valley-fill sediments allowing common excavation. The remaining 37 miles of pipeline would be on badly weathered igneous and metamorphic rocks which probably would require extensive stripping and rock excavation.

The water diverted from San Diego Aqueduct would require some reregulated along the route. It is assumed that Lake Henshaw would

Table 9
BORREGO SPRINGS RESERVOIR SITE DATA 1/
Inland Basins Projects, California
Borrego Valley

Dam	
Type of Structure	Earthfill
Crest Length	1,000 feet
Crest Elevation	820 feet
Maximum Height of Dam	120 feet
Spillway Capacity	2,000 cfs
Reservoir	
M&I Storage	1,100 acre-feet
Sedimentation 2/	90 acre-feet
Standby Storage	500 acre-feet
Maximum Water Surface Elevation	800 feet

1/ Based on reconnaissance data.

2/ 100-year sediment.

be the ideal location for this type of regulation. This would require the agreement and cooperation of Vista Irrigation District to use Lake Henshaw. The present capacity of Lake Henshaw is 194,323 acre-feet. There is sufficient capacity available to provide the necessary reregulated.

From Lake Henshaw to Borrego Valley several major faults, including the active Elsinore zone, would be transected. This route is shown on General Map No. 1015-326-27 and pertinent data for the route are shown in Table 10.

b. Oasis-Borrego Route. Delivery of import water through the Coachella distribution system would be taken near Oasis, California. From this delivery point a pipeline called Oasis-Borrego Route would convey the water to the proposed Borrego Springs Reservoir.

This conveyance route would traverse unconsolidated alluvial sediments with lacustrine facies, and older, well-compacted sandstone and clay deposits. Excavation would be common and limited areas of expansive clays may be encountered. Both the active San Jacinto and San Felipe Hills fault zones would be crossed east of Borrego Sink. This route is shown on the General Map No. 1015-326-27 and pertinent data for the route are shown in Table 10.

c. Westside-Borrego Route. Delivery of import water through the Imperial Irrigation District's canal system would be from the Westside Main Canal in Section 29, R. 12 E., T. 15 S. From this point the water would be conveyed by a pipeline, called Westside-Borrego Route, to Borrego Springs Reservoir.

Table 10
PROJECT CONVEYANCE FACILITIES DATA
Inland Basins Projects, California
Borrego Valley

Plan of Development	Conveyance System	Design Capacity	Type	Length	Number of Pumps	Total Static Lift for Pipeline
Development Plan A	Escondido-Borrego Route	25 cfs (17,000 acre-feet per year)	Steel Pipeline (57-inch Diameter)	52 miles	9	7,200 feet
	Oasis-Borrego Route	25 cfs (17,000 acre-feet per year)	Steel Pipeline (57-inch Diameter)	20 miles		
			Concrete Pipeline (57-inch Diameter)	21 miles	3	980 feet
	Westside-Borrego Route	25 cfs (17,000 acre-feet per year)	Steel Pipeline (57-inch Diameter)	13 miles		
			Concrete Pipeline (57-inch Diameter)	40 miles	1	800 feet
Development Plan B	Westside-Borrego Route	725 cfs	Open Channel	40 miles		
			Steel Pipeline (180-inch Diameter)	13 miles	1	800 feet

Recent alluvial deposits and lacustrine clays, and older terraces underlie this route. Excavation would be normal, but expansive clays and low density lacustrine deposits should be avoided, especially as a foundation for pump plant facilities. This route is shown on the General Map No. 1015-326-27 and details for the Westside-Borrego Route are shown in Table 10.

As shown on General Map No. 1015-326-27, this route crosses the U. S. Naval Gunnery Range. For this report it was assumed that permission could be obtained to cross the gunnery range. If additional studies are made, this potential problem should be investigated more thoroughly.

2. Development Plan B. Development Plan B would permit importation of sufficient water to meet the ultimate industrial, municipal, and agricultural demands. Delivery of this water would be through the Westside Main Canal and a turnout located at the same point as the corresponding import plan for municipal and industrial water only. A combination of open canal and pipeline would convey the water from the Westside Main Canal to Borrego study area, using the same alignment as the Westside-Borrego Route. Agricultural water deliveries could be made as the conveyance system crosses the valleys and municipal and industrial water could be delivered to the Borrego Springs Reservoir. Pertinent data for this route are shown in Table 10.

C. Project Development Costs

Reconnaissance level cost estimates of the two plans presented in this report are shown in Table 11. Cost estimates include right-of-way

Table 11
ESTIMATED COST OF DEVELOPMENT PLANS
Inland Basins Projects, California
Borrego Valley

Plan of Development	Conveyance System	Total Construction Cost	Annual OM&R	Annual Power Cost
Development Plan A	Escondido-Borrego Route	$53,402,000	$318,300	$1,980,000
	Oasis-Borrego Route	$30,122,000	$ 87,000	$ 267,000
	Westside-Borrego Route	$33,427,000	$ 45,000	$ 220,000
Development Plan B	Westside-Borrego Route	$50,523,000	$152,000	$4,004,000

acquisition, engineering, and supervision of construction. The cost estimates are based on designs prepared for this report.

Construction and OM&R costs of two of the conveyance systems for municipal and industrial water under Development Plan A are quite similar. These conveyance systems are the Oasis-Borrego Route and the Westside-Borrego Route. The difference in the cost of these routes is not appreciable. Both routes are considerably cheaper in both construction cost and OM&R cost than the Escondido-Borrego Route.

Unless extremely low initial water costs become obtainable in the coastal area of southern California, importations through the Escondido-Borrego Route would not appear feasible. The Oasis-Borrego and the Westside-Borrego Routes are potentially feasible for importation of water and future selection will depend upon provision of a dependable economical source of water.

D. Sedimentation

No field evaluation of sediment yield potential was made for the proposed Borrego Springs Reservoir; however, it is believed that the anticipated sediment inflow would follow the sedimentation pattern in Hemet Lake, approximately 30 miles to the north of the study area.

By using what is known about the behavior of Hemet Lake and adjusting for the noncontributing surface drainage of Borrego Springs Reservoir, a modification of the general sediment curve (furnished by the Chief Engineer's Office) yielded a 100-year sediment inflow of 90 acre-feet.

PART VII

ECONOMIC ANALYSIS

VII. ECONOMIC ANALYSIS

A. Economy of the Area

The economy of the Borrego study area is largely dependent upon agriculture, construction, recreation, tourism, and commercial trade. Retirement developments are also becoming an important segment of the economy as they enlarge the permanent population and provide income from outside the area.

1. Agriculture. The leading agricultural crop in Borrego Valley is grapes. In recent years the relative importance of this crop has diminished from a peak of 4,200 acres in 1952 to about 700 acres in 1966. The reasons for this decline are: (1) pressures of urban subdivision of land; (2) relatively low yield in recent years due to varying weather conditions; and (3) high production costs and increased labor and transportation charges.

Alfalfa was once important to the area. In 1955, there were over 7,000 acres of alfalfa, but today only about 550 acres are grown. Cotton acreage has been generally uniform in recent years at between 300 and 350 acres, but grapefruit acreage has declined from about 200 acres to less than 100 acres. Again, the major cause of decline has been land subdivision for urban or recreational development. However, plans are under way to plant new citrus and the results of this venture could have a significant bearing on the future of agriculture in the valley.

Water, land, labor, and transportation costs are the key economic variables in determining the ability of local farmers to compete with farmers in other areas of southern California. Land and labor costs are in an inflationary spiral throughout the region. Cropping patterns are being modified because of changes in the Bracero program. However, despite these restraining influences, if specialized high-return crops such as citrus can be successfully grown, agriculture could become important to the local economy.

2. Recreation. In the past 25 years, desert residential-resort areas have ascended in popularity and such desert areas as the Palm Springs and Salton Sea resorts have experienced phenomenal growth. The rapidly increasing population of nearby coastal areas is expected to further increase the demand for commercial and public outdoor recreational opportunities.

Borrego Valley is in an excellent position to benefit from this trend. The Salton Sea and Anza-Borrego Desert State Park are important recreation resources that have extensive undeveloped potential. The strategic location of the study area adjacent to the Salton Sea and within the State Park area is a significant factor in its present growth rate. Horseback riding, hiking, and desert jeeping are popular activities in the State Park, and fishing and water sports opportunities are available within easy driving distance at the Salton Sea.

Today, most of the recreational facilities are private and commercial. However, the compelling force of ever-greater numbers of park visitors and part-time residents will require additional public, private, and commercial facilities.

Guest ranches, resort hotels, motels, camping grounds, and trailer sites are presently available. The new Borrego Springs Park development has a regulation 9-hole golf course and a par-3, 9-hole course;

and plans have been drawn for an additional 18 holes of regulation golf and another 9 of par-3 holes. The private De Anza Country Club has another golf layout of regulation 18 holes. Public and private swimming pools have been built and more will be needed.

A new Borrego Springs Tennis Racquet Club is planned. This multimillion dollar development would occupy a 95-acre site near the De Anza County Club and would eventually have 10 tennis court sections and a clubhouse surrounded by 250 residential units.

3. Industry. The construction industry has become very active recently in Borrego Valley. In 1955, the homebuilding count was 24 units valued at about $200,000. In 1965, 75 units were started with a total valuation in excess of $1 million. In addition, a $1 million shopping center is near completion and an $850,000 high school is partially completed.

Road construction has also been important. The recent completion of Montezuma Road through the San Ysidro Mountains gives Borrego Valley a direct access route to the coast. A new road is under construction from Borrego Springs to the Salton Sea and streets are continually being paved as new subdivisions develop.

The only local manufacturer is a cabinet shop. Most business establishments are oriented to construction, recreation, tourism, and agriculture. Public facilities have been enlarged somewhat to accommodate greater numbers of tourists and temporary residents.

As the economy becomes stronger some diversification in the form of light industry might be advantageous. Consequently, land has been set aside and plans drawn for an industrial park.

4. General Economic Indicators. The estimated total assessed valuation of the study area is now $6.5 million. Postal receipts are now in excess of $12,000 annually. Annual visitation to the Anza-Borrego Desert State Park has been approximately 400,000 visitor use-days in recent years, and visitor use-days at the Salton Sea are now about 1.6 million annually.

5. Population Projections. The 1960 census for the Borrego Division (approximately coincident with the study area) was 979 people. Current estimates place the population at 1,300 or about a 33 percent increase since 1960. In relation to recent population growth patterns in southern California, this 33 percent increase is above average.

In this report the Stanbery technique 1/ was used as the basic principle for determining population projections in the study area. Borrego is subject to a large net migration because it is near the San Diego and Los Angeles metropolitan areas. Regardless of its population growth, Borrego Valley is likely to remain essentially a retirement, winter recreation, and resort community.

The major population center is Borrego Springs with a population of about 1,000. An additional 200 residents reside in and around the town of Borrego. The Lower Borrego Valley has a population of about 100 which is mainly in the Ocotillo Wells area. This ratio of population distribution between the valleys will probably continue for some time, since almost all of the economic growth in the near future is expected to occur in Borrego Valley.

1/ Stanbery, Van Beuren, "Some New Techniques for Area Population Projections," 1959.

The resultant population projections and the population density per square mile, based on the estimate for the combined valley area of 122 square miles, are shown in Table 12.

A comparison of the study area's projected population growth with that of San Diego County and the State of California is shown on Table 13. It can be noted that the percentage of population increase in 10-year periods rises sharply in Borrego until 1990, and then moves downward; while the county and State 10-year growth rates are already decreasing.

It should also be noted that during the winter tourist season, October through April, from 50 to 75 percent of the people are temporary residents and are not included in population statistics. In addition, State Park visitors and other tourists and vacationers frequently increase the population even more, particularly on certain weekends.

B. Economic Justification

This section presents a partial analysis of the economic justification of developing a conveyance system to import water into the basin. Economic justification is normally demonstrated by comparing project investment and OM&R costs with project benefits. For the plans in this report, the measurable monetary benefits would accrue to municipal, industrial, and agricultural water services. However, the benefit-cost analysis is incomplete, since municipal and industrial benefits were not computed.

The following analysis is based on a 100-year period and an interest rate of 3-1/8 percent:

Table 12
POPULATION AND DENSITY PROJECTIONS
Inland Basins Projects, California
Borrego Valley

	Borrego Valley (89 Square Miles)		Lower Borrego Valley (33 Square Miles)	
Year	Population	Density Per Square Mile	Population	Density Per Square Mile
1965	1,200	13.5	100	3.0
1970	1,900	21.3	100	3.0
1980	5,300	59.6	200	6.1
1990	9,650	108.4	350	10.6
2000	15,450	173.6	550	16.7
2010	21,750	244.4	750	22.7
2020	29,000	325.8	1,000	30.3

Table 13
POPULATION PROJECTION COMPARISON
Inland Basins Projects, California
Borrego Valley

	Borrego Study Area 1/		San Diego County 2/		California 2/	
Year	Population	Percent Change By 10-year Periods	Population	Percent Change By 10-year Periods	Population	Percent Change By 10-year Periods
1960	979	----	1,033,000	----	15,717,204	----
1970	2,000	51.0	1,455,000	40.8	21,700,000	38.1
1980	5,500	63.6	1,900,000	30.6	28,200,000	30.0
1990	10,000	81.8	2,350,000	23.7	35,000,000	24.1
2000	16,000	60.0	2,800,000	19.1	42,000,000	20.0
2010	22,500	40.6	3,150,000	12.5	49,000,000	16.7
2020	30,000	33.3	3,455,000	9.7	56,000,000	14.3

1/ Bureau of Reclamation.

2/ Bulletin No. 78-D, California Department of Water Resources.

1. Project Benefits.

a. Municipal and Industrial Benefits. Municipal and industrial water supply benefits are usually measured by the cost of providing an equal water supply by the most likely alternative means that would be utilized in the absence of the Federal project.

It would be very expensive to import a water supply to Borrego Valley to meet only the municipal and industrial water requirements, as will be shown in the subsequent analysis of project costs. Moreover, it appears from the previous discussion in Part V that the projected growth in municipal and industrial water requirements could be provided by further development and management of local ground-water resources, provided: (1) the available ground-water supplies are not depleted by increased pumping for irrigation and (2) the quality of these ground-water supplies continues to meet applicable standards for municipal and industrial uses.

Whether a plan for ground-water basin management--to conserve, utilize, and maintain the quality of available supplies for municipal and industrial purposes--would be physically practicable or economically justified was not determined. To develop an acceptable plan would require, in addition to physical solutions, the resolution of organizational and water rights questions which are properly matters of local concern and beyond the scope and purpose of this report.

A local basin-management plan, however, might well be the most likely and least costly alternative that would be adopted in the absence of a Federal importation project. Since costs of this alternative have not been estimated, project benefits that would be attributable to a possible future importation of water to meet municipal and industrial demands were not determined. For the purpose of this report, however, a comparison of the costs of various representative plans for transporting a municipal and industrial water supply to Borrego Valley will give some indication as to their relative practicability.

b. Irrigation Benefits. Direct irrigation benefits are the increase in net farm income resulting from the application of project water. Indirect irrigation benefits are the increase in the net income of persons other than water users, as a result of the increased flow of agricultural products from the area. The increased income is estimated by the use of factors representing the ratio of a share of profits in later processing to the increased values of farm sales.

No farm budgets have been made for crops grown in the study area. Therefore, it was necessary to use budgets prepared for another area for purposes of comparison. Farm budget analyses for grapefruit and grapes, prepared for the Coachella Valley County Water District, were used as a guide in approximating the benefits. Delivery of project water for use on irrigable lands in the study area would result in accrual of both direct and indirect irrigation benefits.

Using the Coachella Valley County Water District budgets for grapefruit and grapes as a guide, total direct irrigation benefits \$259.40 per acre and indirect benefits of \$211.96 per acre are derived. These benefits are summarized in Table 14.

Grapes and grapefruit are permanent crops which do not reach full productivity for at least five years after planting. Therefore, computed benefits per acre-foot of water are multiplied by a factor

Table 14
COMPARISON OF IRRIGATION BENEFITS 1/
Inland Basins Projects, California
Borrego Valley

	Coachella Valley County Water District 2/	Borrego Valley
Direct Benefits per Acre	$259.40	$259.40
Indirect Benefits per Acre	211.96	211.96
Total Benefits per Acre	$471.36	$471.36
Farm Delivery Requirement in Acre-Feet per Acre	6.72 3/	6.50 3/
Total Benefits per Acre-Foot	$ 70.14	$ 72.52

1/ Irrigation benefits per acre determined for Coachella Valley County Water District in February 1966 were used for Borrego Valley. Grapefruit and grapes are used as a base for both direct and indirect benefits.

2/ Benefits per acre are assumed to be identical in both projects.

3/ Farm delivery requirement for Borrego Valley citrus is 7 acre-feet per acre, and 6 acre-feet per acre for deciduous fruit; and for the Coachella Valley County Water District 6.86 and 6.58 acre-feet per acre, respectively. Assuming a 50-50 percent development between deciduous and citrus crops in the Borrego Valley, the average farm delivery requirement is 6.5 acre-feet per acre and for Coachella Valley County Water District 6.72 acre-feet per acre.

of 90.5 percent to take into consideration this development period. Based on the data shown in Table 6, the average annual irrigation water requirement over the 100-year period of analysis, at maximum agricultural development, is estimated to be 177,000 acre-feet per year. This requirement is multiplied by the adjusted benefits per acre-foot to obtain the annual equivalent benefits, as summarized in the following tabulation:

Annual Equivalent Water Requirement	Benefits Per Acre-foot	Development Period Factor	Adjusted Benefits Per Acre-Foot	Annual Equivalent Benefits
177,000	$72.52	0.905	$65.63	$11,617,000

c. Intangible Benefits. Providing a full water supply would also contribute many intangible benefits such as enhancement of industrial and residential growth, increased employment and investment opportunities, and more effective use of natural resources.

2. Project Costs. Project costs are based upon reconnaissance level estimates. The costs of constructing project facilities are included for comparison purposes. The cost for each plan of development includes interest during construction. To make plans comparable it was necessary to convert all costs to annual equivalent values. The Federal costs of Plans A and B are summarized in Table 15.

3. Discussion of Benefits and Costs. In Table 15 it is evident that the average annual cost per acre-foot of conveying a water supply to serve only the municipal and industrial requirements (Plan A) would be expensive. Under Plan B, which would provide water for both irrigation and municipal and industrial use, there would be substantial savings in the average conveyance cost per acre-foot. However, the

Table 15
SUMMARY OF FEDERAL ECONOMIC COSTS
(3-1/8 Percent Interest, 100-Year Period of Analysis)
Inland Basins Projects, California
Borrego Valley

Plan of Development	Conveyance System	Construction Cost	Interest During Construction 1/	Total Capital Investment 2/	Annual Equivalent Investment 3/	Annual OM&R and Power Cost	Total Annual Cost	Average Annual Water Delivery (Acre-Feet)	Average Annual Conveyance Cost per Acre-Foot 5/
Plan A	Escondido-Borrego Route	$53,402,000	$4,255,000	$57,657,000	$1,889,000	$1,355,000	$3,244,000	7,400	$438
	Oasis-Borrego Route	30,122,000	1,694,000	31,816,000	1,042,000	227,000	1,269,000	7,400	171
	Westside-Borrego Route	33,427,000	1,880,000	35,307,000	1,157,000	160,000	1,317,000	7,400	178
Plan B	Westside-Borrego Route	50,523,000	2,842,000	53,365,000	1,748,000	3,416,000	5,164,000 4/	184,000	28

1/ Computed at 3-1/8 percent simple interest.

2/ Investigation costs are excluded.

3/ 100-years at 3-1/8 percent interest.

4/ Includes irrigation costs.

5/ Total Annual Cost divided by Average Annual Water Delivery.

economic justification of importing a future water supply for irrigation development in Borrego Valley would depend greatly on the cost of the water at the point of delivery to the project conveyance system. The acquisition cost of the water would be added to the conveyance cost shown in Table 15 to obtain the cost of the water delivered to Borrego Valley. Comparison of these combined costs with the project benefits would then indicate whether the project would be economically justified by an excess of benefits over costs.

As previously noted, the irrigation benefits under Plan B would be about $66 per acre-foot of irrigation water provided. The average conveyance cost, from Table 15, would be $28 per acre-foot. This implies that there would be residual irrigation benefits of $38 per acre-foot to support the cost of import water. To complete the analysis of economic justification, however, the benefits that would accrue to the municipal and industrial water supply under Plan B would also have to be determined and considered.

Although incomplete, this analysis suggests that, if an economical water supply becomes available for importation to Borrego Valley, the cost of Plan B might be economically justified on the basis of a favorable benefit-cost ratio.

C. Financial Analysis

1. Cost Allocation. All costs under Plan A would be charged to municipal and industrial water users. Plan B project cost would be shared by agricultural, municipal and industrial water users.

2. Unit Costs of Water. All four plans could ultimately deliver about 17,000 acre-feet annually for municipal and industrial use.

Municipal and industrial investment costs would be reimbursable with interest over a 50-year period.

Plan B, Westside-Borrego Route, could deliver both irrigation water and municipal and industrial water. The total cost of this plan has been distributed between municipal and industrial and irrigation water functions on a proportionate-use-of-facilities basis. Under Plan B, 92.6 percent of the water would be for irrigation and 7.4 percent would be for municipal and industrial use. Table 16 shows that Plan B has the lowest cost per acre-foot of water delivered, due to conveyance of a greater quantity of water.

3. Repayment Methods. This report does not attempt to make a determination as to how the project could be repaid, but only suggests some methods which might be employed. These methods are:

a. A flat rate per acre-foot of import water sufficient to repay the cost of facilities.

b. An ad valorem tax levied and administered by the contracting agency receiving the water.

c. A nominal flat rate per acre-foot charge for surface water plus enough taxation to repay the balance of the cost of facilities.

d. Combinations of the above methods.

The Borrego Valley Water District and the Borrego Springs Park County Water District have the power to tax to help repay any future proposed project costs. Either or both of these water districts could be a contracting water agency for the Borrego study area.

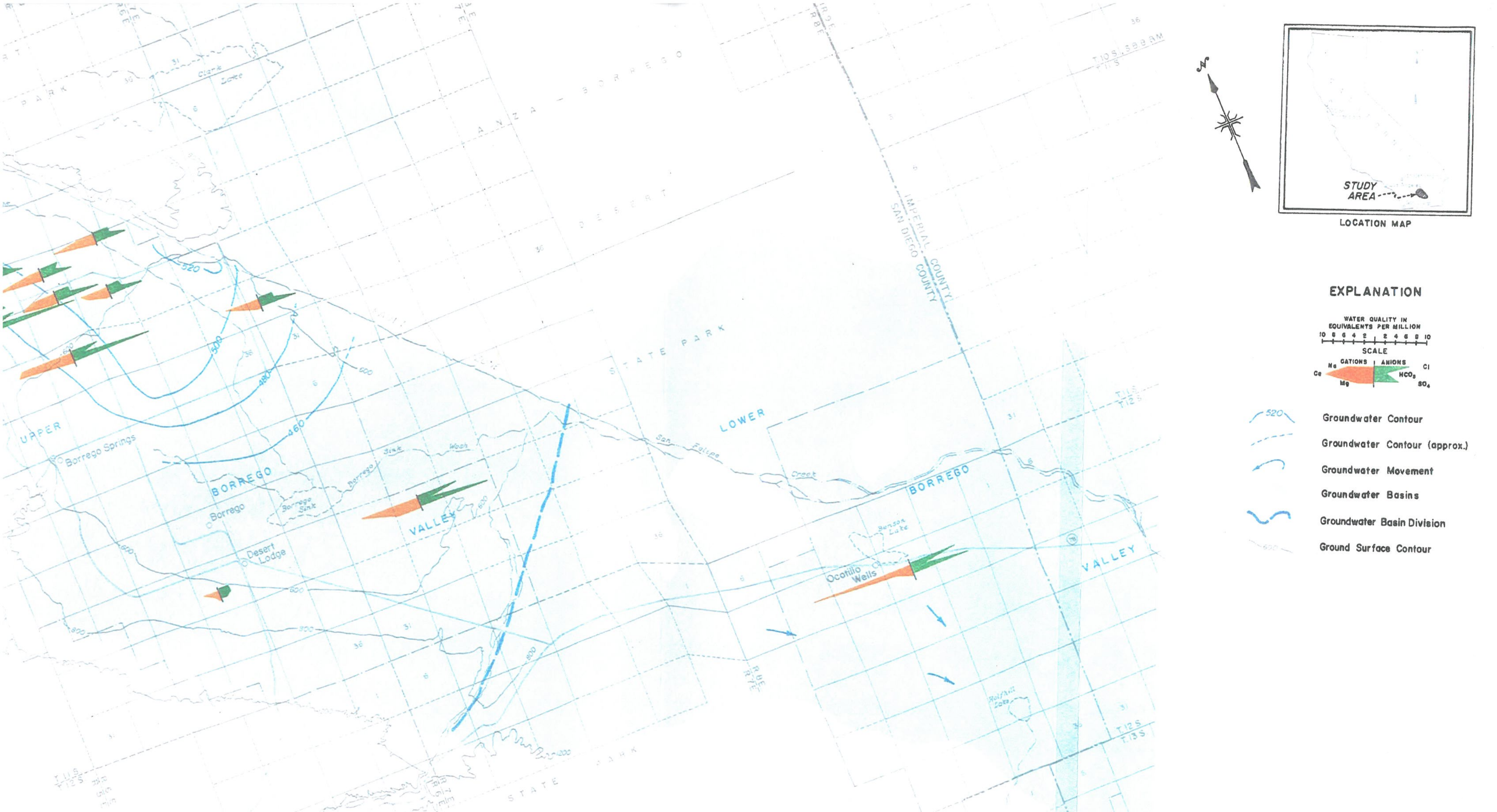
Table 16
UNIT COST OF WATER 1/
Inland Basins Projects, California
Borrego Valley

Development Plan and Conveyance System	Reimbursable Investment Cost (1)	Annual Equivalent Investment Cost (2)	Annual OM&R & Power Cost (3)	Total Annual Cost (4)	Avg. Annual Water Delivery (Acre-Feet) 2/ (5)	Unit Cost of Delivery System per Acre-Foot 3/ (6)
Plan A						
Escondido-Borrego Route	$57,793,000	$2,341,000	$ 860,000	$3,201,000	7,400	$432.57
Oasis-Borrego Route	31,870,000	1,291,000	160,000	1,451,000	7,400	196.08
Westside-Borrego Route	35,367,000	1,432,000	105,000	1,537,000	7,400	207.70
Plan B						
Westside-Borrego Route						
M&I Water	3,956,000	160,000	250,000	410,000	7,400	55.40
Irrig. Water 4/	46,784,000	936,000	3,133,000	4,069,000	176,600	23.04
All Water	$50,740,000	$1,096,000	$3,383,000	$4,479,000	184,000	$24.34

1/ Based on reimbursable irrigation and M&I costs only. M&I costs include interest at 3.225 percent. Repayment period is 50 years. Cost of obtaining water for importation is excluded.
2/ Average annual water delivery over 50-year period (1970-2020) is derived from Tables 6 and 8.
3/ Column 4 divided by Column 5.
4/ Excludes all interest charges, including interest during construction.

No payment capacity budgets were made for Borrego Valley crops. It is doubtful, however, that the payment capacity of grapefruit and grapes would be great enough to meet the probable cost of irrigation water delivered to Borrego Valley.

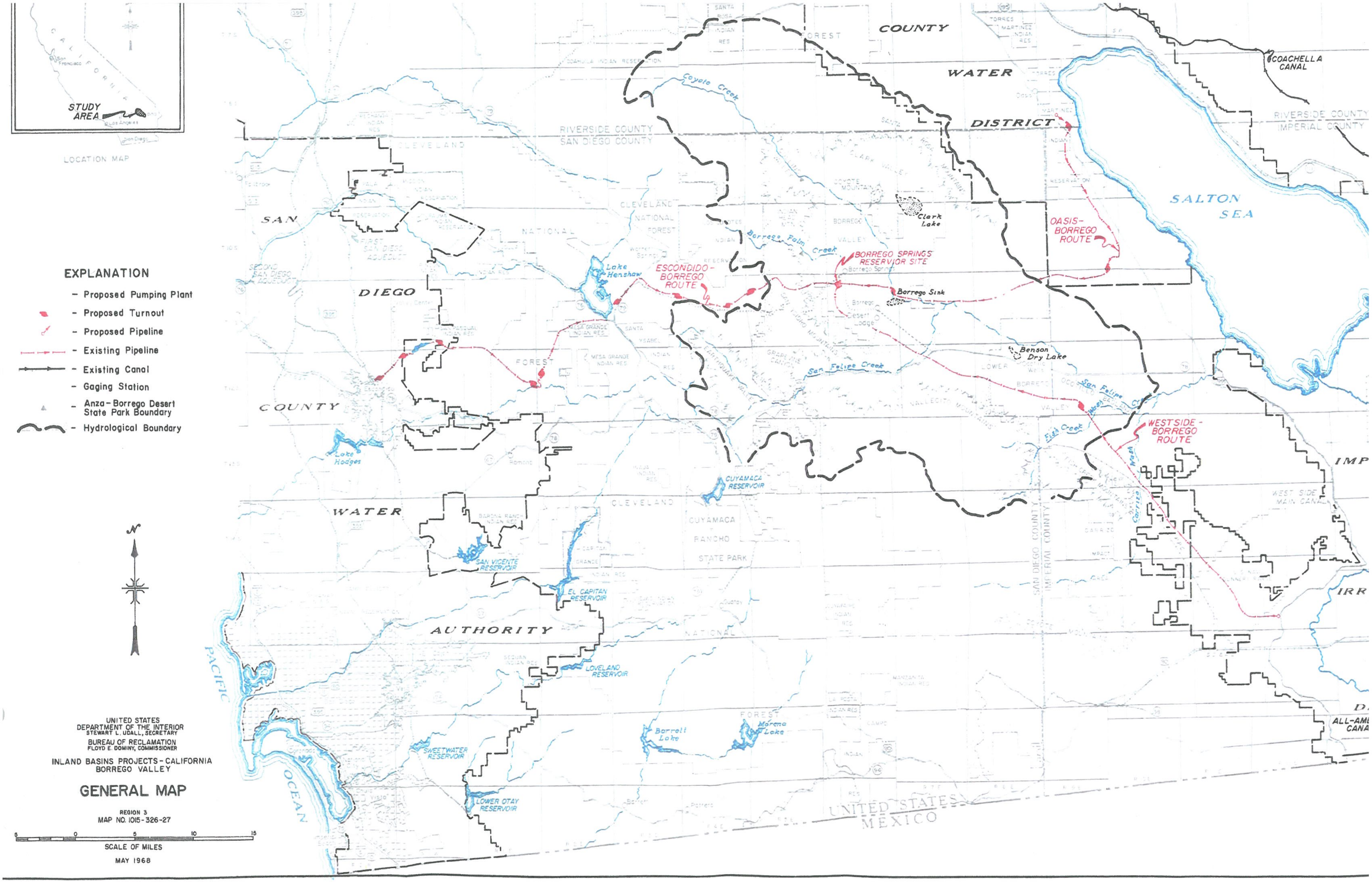
The payment capacity of a single-crop 160-acre farm, estimated from farm budgets for nearby Coachella Valley, indicates that $25 per acre-foot is about the maximum amount that farmers could afford to pay for irrigation water in the Coachella area. This would indicate that ranchers in Borrego Valley probably could not now afford the cost of import water to irrigate grapefruit and grapes. Therefore, a more detailed study--including Borrego Valley farm budgets for these and other specialty crops suitable to the area--would be necessary to determine project feasibility, whenever it appears that an economical water supply might be made available for importation.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
INLAND BASINS PROJECTS—CALIFORNIA
BORREGO VALLEY

GENERALIZED GROUNDWATER BASIN, QUALITY & MOVEMENT

DRAWN.................. SUBMITTED..................
TRACED.................. RECOMMENDED..................
CHECKED.................. APPROVED
SAN BERNARDINO, CALIF.



STUDY AREA
LOCATION MAP
EXPLANATION
- Proposed Pumping Plant
- Proposed Turnout
- Proposed Pipeline
- Existing Pipeline
- Existing Canal
- Gaging Station
- Anza-Borrego Desert State Park Boundary
- Hydrological Boundary
UNITED STATES
DEPARTMENT OF THE INTERIOR
STEWART L. UDALL, SECRETARY
BUREAU OF RECLAMATION
FLOYD E. DOMINY, COMMISSIONER
INLAND BASINS PROJECTS - CALIFORNIA
BORREGO VALLEY
GENERAL MAP
REGION 3
MAP NO. 1015-326-27
SCALE OF MILES
MAY 1968
COUNTY
WATER
DISTRICT
COACHELLA CANAL
RIVERSIDE COUNTY
IMPERIAL COUNTY
RIVERSIDE COUNTY
SAN DIEGO COUNTY
SALTON SEA
Coyote Creek
CLEVELAND
NATIONAL
FOREST
Clark Lake
OASIS-BORREGO ROUTE
Borrego Palm Creek
BORREGO SPRINGS RESERVOIR SITE
Lake Henshaw
ESCONDIDO-BORREGO ROUTE
Borrego Sink
SAN
DIEGO
COUNTY
WATER
AUTHORITY
Benson Dry Lake
San Felipe Creek
WESTSIDE-BORREGO ROUTE
Fish Creek
Lake Hodges
CUYAMACA RESERVOIR
CUYAMACA
RANCHO
STATE PARK
WEST SIDE MAIN CANAL
SAN VICENTE RESERVOIR
EL CAPITAN RESERVOIR
SAN DIEGO COUNTY
IMPERIAL COUNTY
LOVELAND RESERVOIR
PACIFIC
OCEAN
SWEETWATER RESERVOIR
Barrett Lake
Morena Lake
LOWER OTAY RESERVOIR
UNITED STATES
MEXICO
ALL-AMERICAN CANAL