

**DRAFT
ENVIRONMENTAL IMPACT REPORT**

SCH No. 83071102

GROUNDWATER RECHARGE-EXTRACTION PROJECT

FOR

**BERRENDA MESA WATER DISTRICT
KERN COUNTY, CALIFORNIA**

NOVEMBER 1983

**LEEDSHILL-HERKENHOFF, INC.
San Francisco, California**

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SUMMARY

Berrenda Mesa Water District proposes to operate a groundwater replenishment and extraction program on lands it owns adjacent to the Kern River. Replenishment will be effected by spreading water from the Kern River, the State Water Project, and/or other sources onto a portion of the 547-acre property that will be developed as percolation ponds. Water will be extracted in times of drought from wells on the property and exchanged for water from the State Water Project.

A computer model was developed to assess the impact of the recharge and extraction program on the groundwater basin. The model indicates that the program will result in a net increase in groundwater levels in the basin and will thus have a positive benefit to surrounding landowners over a period of time. This will result in lower energy costs for pumping and improved groundwater quality.

Adverse impacts that may be considered significant and the proposed methods of mitigation are:

<u>Impact</u>	<u>Mitigation</u>
. Potential loss of riparian habitat	Designate riparian habitat areas on both sides of river.
. Increased potential of soil liquefaction damage	Perform soil tests to determine liquefaction potential prior to initiating recharge on 160-acre parcel north of Kern River.
. Lowered groundwater levels in study area during periods of extraction	Limit annual extractions.
. Hazard of induced uplift of canal linings	Separate canal embankment from ponds by a levee and monitor groundwater levels.
. Increased health hazard	Establish mosquito abatement program.

Alternatives to the proposed project include no action, operation of the existing spreading basins by Kern County Water Agency, agreements with other water districts to recharge Berrenda Mesa water, and finding an alternative source of water supply for the district in times of drought.

INTRODUCTION

Berrenda Mesa Water District (BMWD) furnishes water for irrigation to an area in northwestern Kern County. The sole source of water to the district is from the State Water Project through contract with Kern County Water Agency. In times of drought there is insufficient water available to sustain the extensive permanent plantings in the district, even though diligent water conservation measures are practiced. To alleviate this condition, BMWD proposes to recharge the Kern County groundwater basin by spreading water in percolation ponds to be constructed on lands which it purchased along the Kern River near Bakersfield. The water for spreading would be obtained from the State Water Project, Kern River and/or other sources. During infrequent periods of extreme drought, BMWD would extract, by pumping from wells to be constructed in the spreading areas, a portion of the groundwater it had recharged.

This report is an assessment of the environmental impact of the proposed project. It was prepared in accordance with the California Administrative Code, Title 14, to comply with the statutes of the California Environmental Quality Act.

In order to assess the impact of the project on the groundwater basin, a computer model was used to simulate conditions as they would have been historically, had the project been in operation.

PROJECT DESCRIPTION

General Description

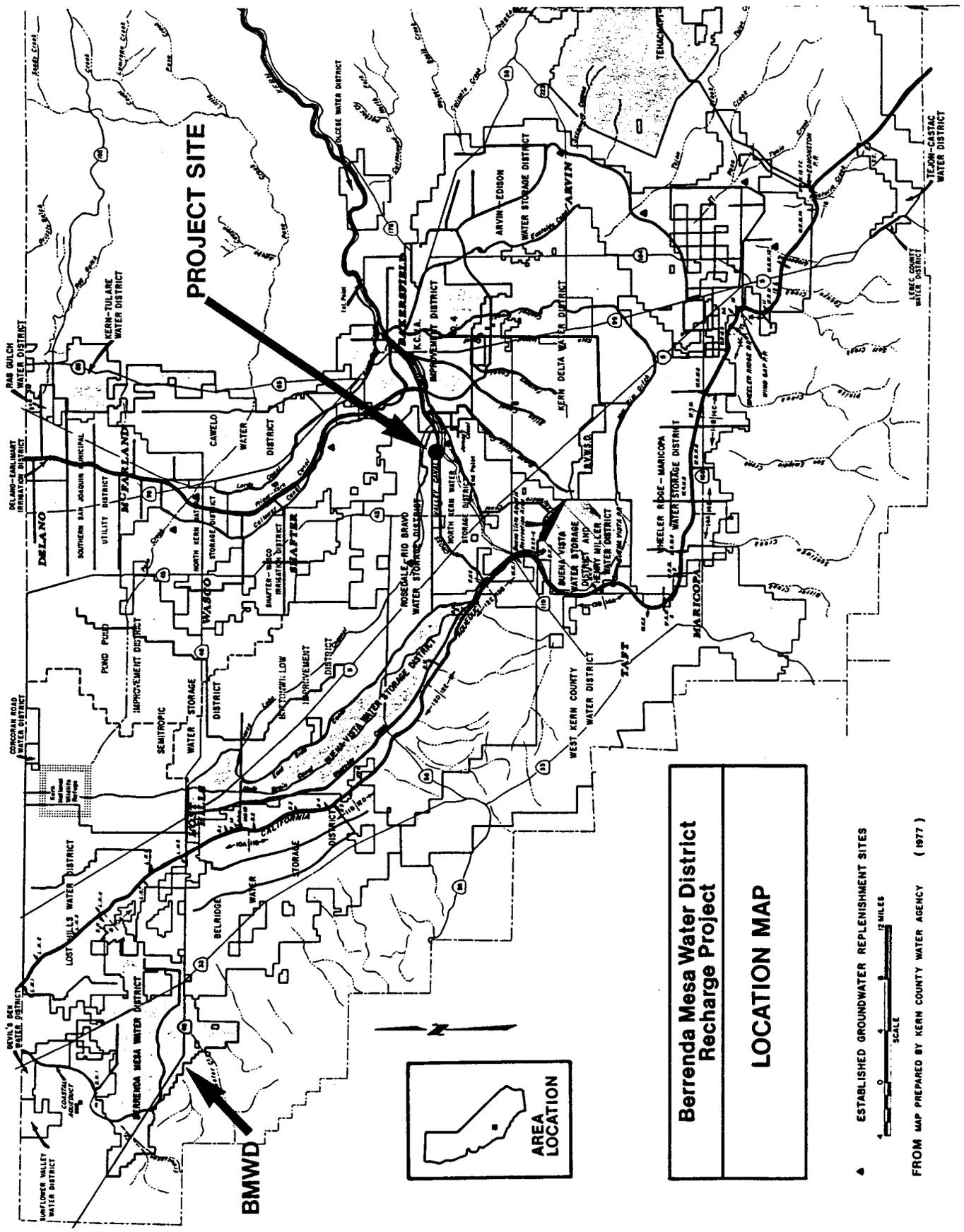
The project area consists of those lands in proximity to the Kern River west of Bakersfield which are owned by BMWD and which are proposed for use in the spreading project. BMWD purchased the project lands in 1980 for the purpose of spreading water. The lands consist of 547 acres, of which about 240 acres located south of the river were developed and used for spreading operations beginning in January 1983 by the Kern County Water Agency.

BMWD currently has a temporary agreement to allow the Agency to recharge water in the presently developed spreading area. The agreement is for the period January 11, 1983 to December 31, 1983 and provides for the spreading of excess Kern River water or excess water from the Kaweah and Tule Rivers which have been diverted into Kern River via the Friant-Kern Canal. The water that is spread under this agreement is considered to be Agency banked water and is available for extraction or other disposition by the Agency in years in which supply from the State Water Project is less than the contract entitlements of the member units.

In years of drought, it is the intent of BMWD to extract water previously recharged by BMWD. BMWD does not intent to extract water recharged by the Kern County Water Agency on BMWD lands.

Project Location

The project location, shown on Figure 1 and Plate 1, is eight miles west of downtown Bakersfield in Kern County. Project lands total 547 acres located in the NW-1/4, SE-1/4 and SW-1/4 of Section 2, and in a portion of SE-1/4 of Section 3, T.30S., R.26E., M.D.B.&M. The 547-acre area includes a 160-acre parcel north of the Cross Valley Canal which was previously farmed, a 240-acre parcel south of the Kern River now being used for spreading by the Kern County Water Agency, a 75-acre undeveloped parcel between the Cross Valley Canal and Kern River, and a 72-acre parcel which consists of a one-mile reach of the Kern



**Berrenda Mesa Water District
Recharge Project**

LOCATION MAP

▲ ESTABLISHED GROUNDWATER REPLENISHMENT SITES

0 4 8 12 MILES

SCALE

FROM MAP PREPARED BY KERN COUNTY WATER AGENCY (1977)

River channel that bisects the property owned by BMWD. Project lands which lie north of the river are within the Bakersfield city limits.

Project Objectives

The proposed project will include a groundwater recharge program that will be effected by diverting and/or pumping surplus water, when available, from the Kern River or Cross Valley Canal into off-channel spreading facilities adjacent to the river. The water will be stored in the groundwater basin for future withdrawal during dry periods. As presently planned, cumulative recharge will always be more than cumulative extractions, thus the average groundwater levels in the basin will be higher with the project than without the project. By raising the groundwater levels in the basin the project will result in lower overall energy requirements for pumping than would prevail without the project.

Sources of Water for Spreading

It is planned to spread water on the BMWD project lands from three sources:

(1) Water available to BMWD from the State Water Project (SWP) through its contract with the Kern County Water Agency (KCWA) in excess of BMWD's current needs.

(2) Water from the Kern River during times when unappropriated water is present in the basin.

(3) Other sources which may become available from time to time such as excess floodwater pumped into the Friant-Kern Canal outside the Kern River basin or from current litigation of Kern River water rights.

SWP Water

As shown on Table 1, the BMWD's entitlement to water from the SWP will increase from 148,900 acre-feet in 1983 up to its maximum of 163,200 acre-feet in

TABLE 1

BERRENDA MESA WATER DISTRICT
ENTITLEMENTS AND DELIVERIES

(Quantities in Thousands of Acre-Feet)

<u>Year</u>	<u>SWP Entitlement</u>	<u>Historical Deliveries</u>
1968	12.4	71.7
69	25.5	52.1
1970	30.6	71.9
71	52.0	98.5
72	89.9	107.9
73	95.6	94.8
74	110.7	103.1
1975	115.1	126.4
76	119.9	126.7
77	33.9	87.8**
78	90.8	90.0
79	133.4	129.8
1980	137.5	135.9
81	141.9	139.6
82	145.8	92.4
83	148.9	
84	152.9	
1985	155.2	
86	158.2	
87	160.2	
88	161.9	
89	162.8	
1990 and Thereafter	163.2*	

* Table 1 Entitlement includes 155,100 acre-feet of firm and 8,100 acre-feet of surplus water in 1990 and thereafter.

** Includes purchase of water from Metropolitan Water District of Southern California.

1990 and thereafter. Under present cropping patterns, BMWWD's demands for water amount to about 140,000 acre-feet as shown for historical deliveries in recent years in Table 1. BMWWD projects no appreciable increase in water requirements in the foreseeable future. Accordingly, in years when BMWWD receives its full entitlement, some water will be excess to their needs. Thus, assuming BMWWD will receive its full entitlement in the near future, the following quantities of water could be available for recharge beginning in 1984.

<u>Year</u>	<u>Quantity Available for Recharge from SWP</u>
1984	12,900
85	15,200
86	18,200
87	20,200
88	21,900
89	22,800
1900 and thereafter	23,200

In addition, the KCWA has surplus water available from time to time, however the cost for such water has not been firmly established and the availability of this water in years when unappropriated water is not available from the Kern River is uncertain.

Kern River Water

In 1969 the largest snowmelt flood of record occurred in the Kern River. In that calendar year 2,313,700 acre-feet was measured at First Point, five miles northeast of Bakersfield (Figure 1). Of this quantity, 300,000 reached Tulare Lake and about 90,000 acre-feet was pumped into the California Aqueduct. Thus, in that year it may be concluded that at least 390,000 acre-feet was not appropriated for use in Kern County.

This major event prompted construction of the Kern River-California Aqueduct Intertie Project in 1977. The Intertie consists of sedimentation and

diversion facilities which permit flow by gravity of floodwater from the Kern River into the California Aqueduct. The objective of the Intertie was described in the Final EIR on the Intertie as follows:

"The objective of the Intertie is to reduce flood damage in areas downstream of the Intertie. Under the proposed plan of operation, the Intertie would divert vagrant snowmelt flood runoff available after all practicable measures have been taken to beneficially divert and use such waters directly or by percolation to the groundwater basin or to otherwise store or dispose of such waters. Thus, only those flood waters would be diverted which remain after all reasonable measures for conservation and use have been exhausted (and which would otherwise cause damage by flooding)."

Thus it is clear that the Intertie may only be used after all practicable measures to beneficially divert Kern River Water have already been taken.

Since its construction in 1977, the following quantities of water in acre-feet were diverted through the Intertie in the years and for the number of days shown in the tabulation below:

<u>Calendar Year</u>	<u>Kern R. Inflow to Intertie</u>	<u>Flow to Intertie From Outside Kern R. Basin</u>	<u>Total Quantity Diverted through Intertie</u>	<u>Number of Days Intertie in Operation</u>
1978	168,818	9,113	177,931	84
1980	138,360	0	138,360	112
1982	10,339	1,019	11,358	15
1983 (through May)	253,418	89,926	343,344	151

Review of the record of flows since construction of Isabella Dam in 1953 indicates that had the Intertie been in operation it might have operated in water year 1966-67 and would have operated in water year 1968-69. The estimated number of days the Intertie would have operated in 1969 was based on the number

of days there was flow at Highway 46. In that year there was continuous flow at Highway 46 for a total of 232 days between February 11 and October 2 except for two days.

In water year 1967, snowmelt flows at First Point (March - September) totaled 1,102,000 acre-feet, a quantity sufficient to flood cells 1 and 2 of Buena Vista Lake but not sufficient to flow into Tulare Lake, according to the U.S. Army Corps of Engineers Project report on the Intertie dated February 1974. However if it was decided to avoid flooding Buena Vista Lake, as in 1978, 1980, 1982, and 1983, the Intertie could have been operated.

The capacity of Buena Vista Lake is 30,000 acre-feet. If the average rate of flow through the Intertie is assumed to be one-half of its capacity of 3,500 cfs, it would take less than 10 days to divert the 30,000 acre-feet. Alternatively there were 19 days after March 1967 when the Kern River discharge at First Point exceeded 4,000 cfs and when diversion into the Intertie might have been made.

Water from Other Sources

During 1983 floodwaters from Tule and Kaweah Rivers which would otherwise flow into Tulare Lake were pumped into the Friant-Kern Canal to flow into the California Aqueduct via the Kern River and the Intertie. In 1983 the KCWA recharged water from this source using 240 acres of BMWD project lands. In the event the system is employed in the future to dispose of such floodwaters, BMWD could divert these flood waters to the spreading area for recharge. However the quantities of such water which might be available to BMWD is difficult to forecast.

At present litigation is underway to establish whether unappropriated water is available from the Kern River system. Should the litigation show unappropriated water to be available, BMWD may be able to obtain a water right to Kern River flows. However, like the vagrant floodwaters imported to the basin via the Friant-Kern, these rights are difficult to quantify at present.

Spreading Facilities

Existing and proposed spreading facilities are illustrated on Figure 2. There is an existing 240-acre spreading area south of the Kern River consisting of six basins which are interconnected by drop inlet structures. At the present time water can be diverted from the river into this area by means of a drop inlet or by diesel driven pumps. The six interconnected basins can be operated using the three upper basins and/or the three lower basins. Levees which contain the basins are typically 12 feet wide and provide a one-foot freeboard on inside levees and a two-foot freeboard on outside levees. In addition to the basins south of the river, there is an area of about 75 acres north of the river which has been partially utilized for spreading by means of a small ditch, but the area has not been leveled or otherwise developed as discrete spreading basins.

There is an area of 160 acres north of the Cross Valley Canal which has not been utilized for spreading but could be so used by building levees and installing diversion works. As shown on Figure 2, four spreading basins are planned for future development in this area. The land in this area has been cultivated for cotton in recent years.

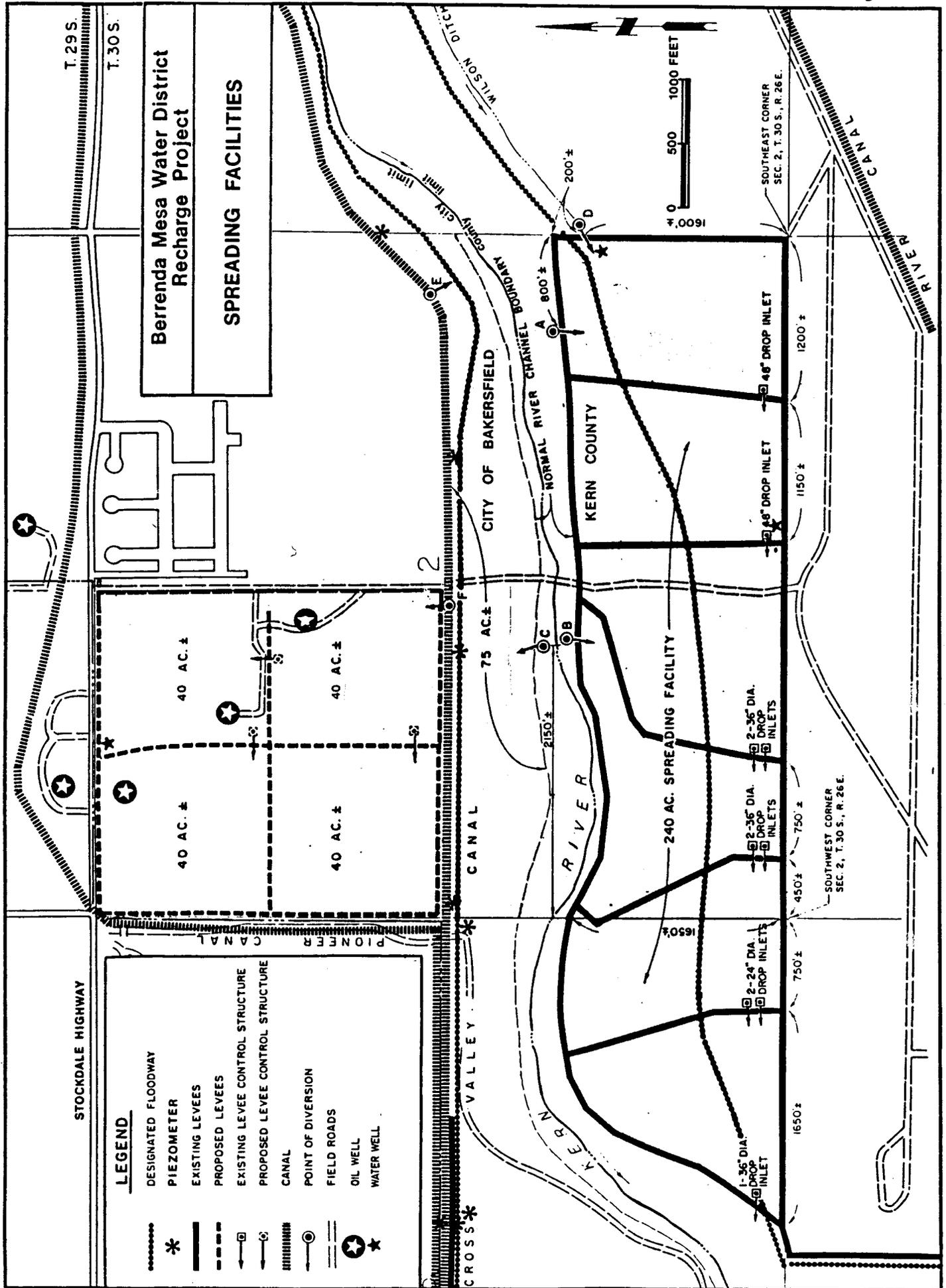
Additionally, the Kern River channel within BMW D lands is dry in many years and may be used for recharge purposes.

Rate of Recharge

The operating results of the Kern County Water Agency, which used 240 acres of BMW D project lands for recharge in early 1983, were reviewed along with the rates of recharge experienced in other nearby operations. On January 7, 1983 the Agency initiated spreading operation on the 240-acre parcel of BMW D lands located south of Kern River. The following quantities were recharged and at rates under two assumptions of water coverage of the spreading grounds.

	Quantity Recharged	Recharge Rate - 240 Acres	
		<u>100% Coverage</u>	<u>80% Coverage</u>
Jan. 7 - 31	2031 acre-feet	0.34 feet/day	0.42 feet/day
Feb. 1 - 28	1176 acre-feet	0.17 feet/day	0.21 feet/day
Mar. 1 - 31	1238 acre-feet	0.17 feet/day	0.21 feet/day
Apr. 1 - 30	257 acre-feet	0.04 feet/day	0.04 feet/day
May 1 - 31	1764 acre-feet	0.24 feet/day	0.30 feet/day

Figure 2



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It is noteworthy that the foregoing rates of recharge were achieved during a wet year which followed other wet years and with maximum interference from the adjacent river and other recharge programs in the vicinity.

Recharge operations have been conducted for a number of years by the Rosedale-Rio Bravo Water Storage District located to the north of the BMWWD lands and by the Kern County Water Agency's Improvement District No. 4 in the Kern River Channel upstream of the District lands. The Rosedale-Rio Bravo WSD 1980 report on the Groundwater Recharge Project indicates that the recharge of facilities operated essentially full time in calendar years 1978 and 1979. During these years total deliveries, less "in lieu" diversion, totaled 81,603 acre-feet and 68,933 acre-feet respectively. If the spreading areas is taken to be 410 acres the daily rates of recharge the corresponding average rates of recharge are 0.46 and 0.54 feet per day.

Kern County Water Agency (1975) indicated that the 10.5 mile reach of the Kern River channel has a capacity of 250 cfs of flowing water. If the width of the river is taken to be 500 feet this rate of recharge corresponds to about 0.8 feet/day.

Extraction Facilities

There are presently four water wells located on project lands, of which three wells are fitted with pumps. The location of the wells is shown on Figure 2. The three pumps have capacities ranging from 1300 to 2000 gpm. Additional larger capacity wells will be constructed in the future to increase the extraction capacity.

Water Transportation Facilities

Water which is extracted from project lands could theoretically be transported to other areas by pumping into the Kern River or into one of several nearby canals (Figure 2). Since groundwater will be extracted only during dry periods, a portion of any water pumped into Kern River or an unlined canal would return to the groundwater basin by percolation.

Accordingly, it is presently contemplated that the groundwater would be exchanged in place or extracted from project lands and pumped into either the Cross Valley Canal, which bisects project lands, or into the River Canal located a few hundred feet south of project lands. Both of these canals are lined. Pumping into the Cross Valley Canal would allow transport of water to Improvement District No. 4 or other entities east of the project, in the normal CVC mode, or transport westward in a reverse CVC mode. Transport via the River Canal would allow delivery to Kern County Water Agency member units located west of the project. Water so delivered would be exchanged for water from the California Aqueduct of the State Water Project.

Monitoring Systems

The amount of water that is recharged and its effect on the water table will be monitored by measuring the amount of water diverted for spreading, changes in groundwater levels, and the evaporation rate. A number of piezometers have been installed by Kern County Water Agency for measuring groundwater levels along the Cross Valley Canal in the vicinity of the present spreading operation. Water is presently measured at diversion points by pumps which are rated for varying head and by weirs on the drop inlet structures.

Operational Plan

Diversions of Kern River water to the off-channel spreading facilities will be initiated when the Kern River-California Aqueduct Intertie begins operation, or when Kern River flood flows are entering Tulare Lake. Such diversions will continue as long as the Intertie continues to operate or Kern River flood flows continue to enter Buena Vista Lake or Tulare Lake. Thus the project will result in conservation of native Kern River water which would otherwise be exported from Kern County or be lost to evaporation.

The off-channel spreading facilities will also be operated from time to time when water in excess of BMWD needs is available from either the State Water Project through the Kern County Water Agency or from other sources. Other

sources could include water from the Tule or Kaweah Rivers or other rivers which flow into Tulare Lake but which can be diverted into the Friant-Kern canal.

As presently planned, water diverted and recharged in the off-channel facilities will be extracted from the groundwater basin during dry years when BMWD experiences shortages in direct deliveries of water from the SWP.

These extractions will be accomplished using existing wells located on the project lands and additional wells to be constructed. Following necessary approvals from the Kern County Water Agency and/or appropriate member units, pumped water will be conveyed from the wells into the River Canal, Pioneer Canal or Cross Valley Canal from whence it can be exchanged for SWP water from the California Aqueduct.

The spreading facilities will be operated to ensure optimum infiltration rates. Experience at other spreading facilities indicates that infiltration rates may be expected to decrease with time. Clogging of the basins by fine grained sediment could be limited by periodically scraping the fine sediments from the floor. However, published data (Gross, et al, 1973) suggest that very fine sediments can infiltrate into the ground to depths where they cannot be practically removed by scraping and thereby lead to long-term clogging of the basin floor. ^{1/} Some efforts have been made to maintain high percolation rates in water spreading basins by addition of organic matter and chemicals and by growing vegetation on the spreading area so that roots can keep the upper layers open (Todd, 1966). It is reported that current percolation rates at the Arvin-Edison Sycamore Creek spreading grounds are about one-third the initial percolation rates that were obtained in 1966 when the spreading grounds were first operated. Efforts will be made to minimize the use of water with high turbidities. Additionally, it is anticipated that the BMWD spreading grounds will require periodic reconditioning to maintain an optimum infiltration rate.

^{1/} A list of references follows the text.

Project Economics

Project costs include those for the following features.

1. Purchase water from SWP.
2. Convey water through Cross Valley Canal.
3. Divert water from Kern River into spreading area.
4. Construct and maintain spreading facilities.
5. Extraction wells.
6. Power cost for pumping.
7. Operation and maintenance costs.
8. Exchange related costs.
9. Land costs

BMWD plans to use a portion of its SWP water which is in excess of its current needs for spreading. Under existing practice, if BMWD elects not to receive its SWP water it could be sold through the Kern County Water Agency pool at the average pool rate. Thus the pool price represents the value of the water to the BMWD. The pool rate for 1983 after March 31 when the SWP energy prices change, is estimated to range from \$23 to \$35 per acre-foot.

Costs for operation, wheeling and pumping in the Cross Valley Canal through pumping plant No.4 amount to about \$10 per acre-foot plus a third party surcharge of \$6 per acre-foot.

Costs to divert water from the Kern River to the spreading area may be made by gravity in some instances, and by pumping in other instances. The average cost has been estimated to approximate \$1.00 per acre-foot.

Construction of spreading facilities in the 240 acre parcel south of Kern River was completed in 1983 by the KCWA at a cost of about \$115,000 or about \$500 per acre. Applying this same unit cost to the parcel north of the Cross Valley Canal results in an estimated construction cost of \$70,000. With contingencies and allowances for legal, administration and engineering, but not financing, the capital cost of the work may be approximated at \$105,000.

Extraction of groundwater would initially be accomplished using three existing wells. These wells, operating over a period of 300 days are capable of pumping approximately 5,000 acre-feet of water. Additional larger capacity wells would be constructed to increase annual extractions first to 20,000 acre-feet annually, and possibly to 40,000 acre-feet annually. The cost for each of these 500 to 700-foot deep wells in 1983 price levels, approximates \$90,000. For a 25-year service life this cost is equivalent to an annual cost of \$10,000.

At a pumping rate of 3,000 gpm operating 90 percent of the time, a single well is capable of producing about 4,000 acre-feet annually. Thus the unit cost per acre-foot of extraction capacity is about \$2.50. For 15,000 acre-feet per year of additional capacity, the annual cost for wells would be \$37,500. For 35,000 acre-feet additional capacity, the cost would amount to \$87,500 per year.

Energy cost to extract water, based on \$0.12 per acre-foot per foot of pump lift and an estimated lift of 120 feet results in a unit cost of \$14.40 per acre-foot. Operation and maintenance costs could amount to as much as \$5.00 per acre-foot making a total of about \$20 per acre-foot to operate the extraction wells.

Additional costs to convey the extracted water depend on the nature of the particular exchange. The foregoing costs are sufficient to supply water in the Cross Valley Canal.

Water Rights

BMWD filed for rights to Kern River water with the State Water Resources Control Board, Division of Water Rights, in October 1982. The application is for a total of 57,000 acre-feet of water annually, of which 30,000 acre-feet would be diverted and recharged in the spreading basins and 27,000 acre-feet would be instream recharge. The application for water rights for instream recharge is for use at times when there is no flow in the Kern River. The water would be stored in the groundwater basin to be extracted later to meet crop needs during a dry year. The application is currently pending.

DESCRIPTION OF EXISTING ENVIRONMENT

For purposes of this report, the environmental setting is considered to be generally all of Kern County west of the Sierra Nevada, but with specific emphasis on project lands and the surrounding area. The period of record for hydrologic data is 1953 to the present, which represents the period during which the operation of Lake Isabella has provided upstream control of flows in Kern River.

Physical Characteristics

Climatic Conditions

The climate in the project area is arid and characterized by hot summers and moderate winters, with average monthly temperatures in Bakersfield ranging from 47.5°F in January to 83.9°F in July. Annual precipitation averages somewhat less than six inches at Bakersfield with most of the rain coming in the months between November and April. The average monthly distribution of temperature and precipitation at Bakersfield is shown on Figure 3, together with the variation in annual rainfall since 1954-55. During these 28 years, the maximum annual rainfall recorded at Bakersfield was 11.42 inches in 1977-78, and the minimum was 1.92 inches in 1958-59.

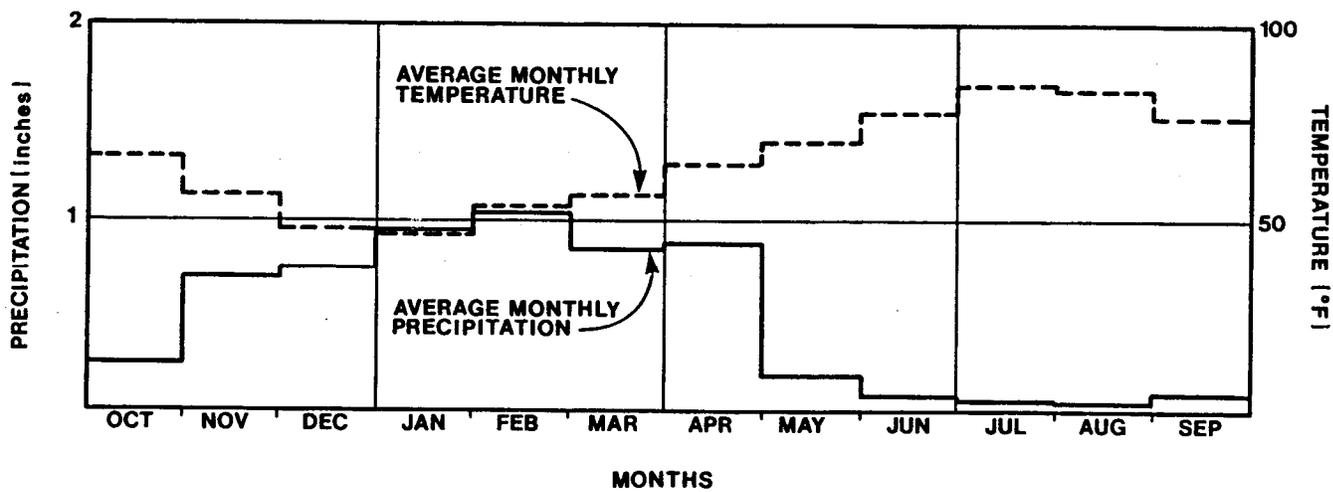
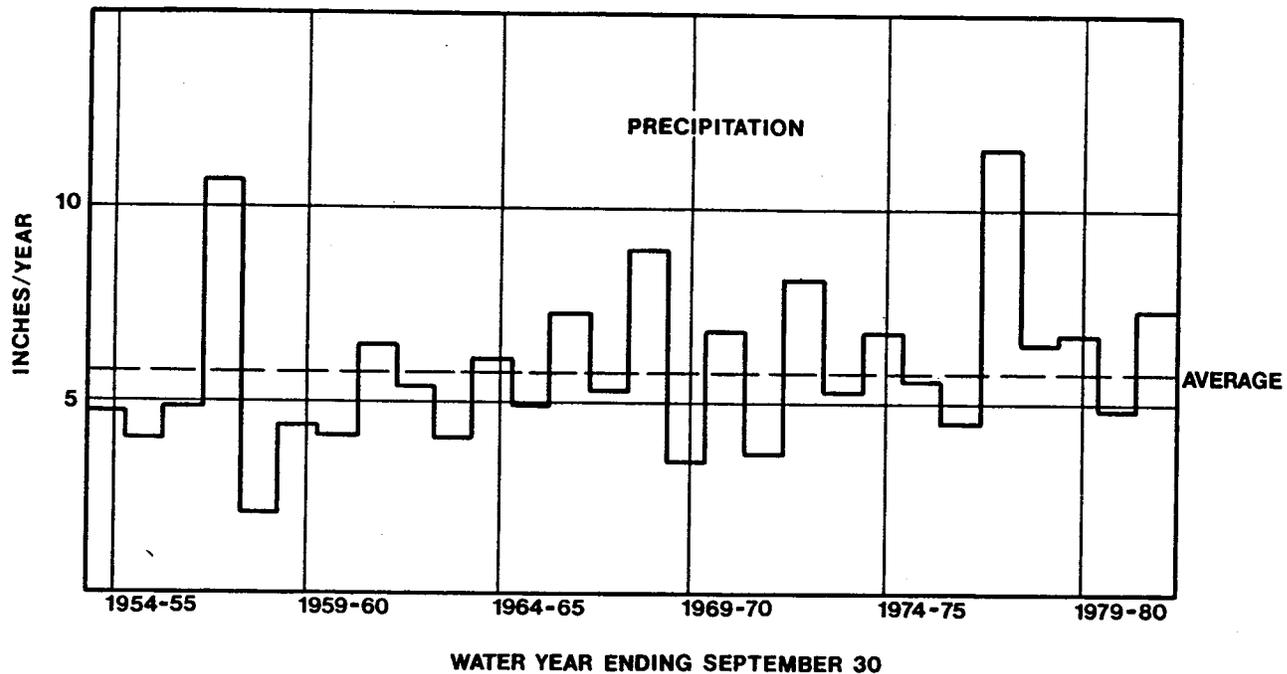
Based on evaporation rates measured by the California Department of Water Resources at agroclimatic stations located on irrigated pasture lands in the San Joaquin Valley, it is estimated that the annual evaporation from spreading ponds such as proposed by BMWWD is approximately 60 inches.

Prevailing winds are from the west, thus a housing development east of the proposed project is downwind.

Air Quality

Air quality has been continuously monitored at several stations in Bakersfield since 1964. The Chester Street air monitoring station reports

CLIMATIC CONDITIONS AT BAKERSFIELD



maximum hourly average concentrations of ozone (oxidant), carbon monoxide, nitrogen dioxide, nitric oxide, oxides of nitrogen, particulate matter and lead. The highest hourly average and the average of the daily hourly maximums of these constituents for February and June, 1982 are shown in Table 2, together with Federal and State ambient air standards. Data for nitric oxide and oxides of nitrogen are not shown as no State or Federal standards have been prescribed.

Suspended particulate matter is measured about five times each month. Each measurement is of a 24-hour sample. The maximum 24-hour measurement and the monthly mean are shown in Table 2. It may be seen that the maximum concentrations of particulate matter in both February and June, 1982, exceeded the State standards but not the Federal standards.

Geology and Seismicity

The project is located in the southern part of the San Joaquin Valley, which is a large alluvial plain underlain by thousands of feet of marine and continental sediments deposited in an asymmetrical geosynclinal trough. Granitic and metamorphic rocks of the tilted Sierra Nevada fault block extend westward with increasing depth beneath the valley to the eastern flank of the Coast Ranges. The mountain ranges which surround the valley were uplifted over a long period of geologic time, but most of the folding, faulting, and mountain building took place in middle Pleistocene time (Hoots, et al, 1954). The sedimentary deposits in the valley also underwent structural deformation at this time.

The dominant physiographic feature in the area of the project is the large alluvial fan of the Kern River sloping towards the west. This fan radiates in a 110 degree arc from an apex near Bakersfield and extends westward about 20 miles, covering an area of about 800 square miles. The fan is composed of alluvial detritus derived from the Sierra Nevada ranges which has been transported by Kern River and deposited in interbedded clays, sands, and gravels. Soils which overlie the alluvium are variable in texture and consistency and generally low in organic matter. When irrigated and well drained, these soils are highly productive for a wide variety of crops.

TABLE 2

CONCENTRATION OF SELECTED AIR CONTAMINANTS AT BAKERSFIELD

CHESTER STREET MONITORING STATION 1/

Contaminant	Unit	February 1982			June 1982			Ambient Air Standards	
		Highest Hourly Average	Average Maximum Hourly Average	Highest Hourly Average	Average Maximum Hourly Average	One Hour Average			
						California	Federal (Primary)		
Ozone	ppm	0.07	0.03	0.11	0.07	0.10	0.12		
Carbon Monoxide	ppm	0.08	0.04	0.03	0.01	40.00	35.00		
Nitrogen Dioxide	ppm	0.09	0.06	0.07	0.04	0.25	N/A		
Nitric Oxide	ppm	0.47	0.19	0.15	0.05	N/A	N/A		
Oxides of Nitrogen	ppm	0.54	0.24	0.21	0.09	N/A	N/A		
Particulate Matter ^{6/}	ug/m ³	161 <u>3/</u>	126 <u>2/</u>	157 <u>3/</u>	142 <u>2/</u>	100 <u>5/</u>	260 <u>5/</u>		
Lead	ug/m ³	0.73 <u>3/</u>	0.500 <u>2/</u>	0.40 <u>2/</u>	0.280 <u>2/</u>	1.5 <u>4/</u>	N/A		

1/ Data from California Air Resources Board "California Air Quality Data".

2/ Highest 24-hour sample collected during month.

3/ Average of four 24-hour samples.

4/ Average for 30 days.

5/ For 24-hour period.

6/ High-volume air sampling.

Most groundwater in the southern San Joaquin Valley occurs in unconsolidated deposits ranging from late Pliocene to Holocene in age. The deposits thicken toward the valley trough and are more than 3000 feet thick beneath Tulare and Buena Vista Lakes (Croft, 1972). Continental deposits on the east side of the valley consist of arkosic beds derived from igneous and metamorphic rocks of the Sierra Nevada, while those on the west and south sides of the valley are generally finer grained and less permeable sediments derived from shales, sandstones and volcanic rocks of the Coast Ranges. Lacustrine and marsh deposits consisting of nearly impermeable gypsiferous fine sand, silt and clay occur as tongues which interfinger with alluvium and act as confining layers in the aquifer. The most extensive of these is the Corcoran Clay on the west side of the valley and the "300 foot" clay on the east side of the valley.

The project is located within Seismic Zone 4, as defined by the Corps of Engineers (1979). In this zone the probability of damage due to earthquake is defined as great. Historically, the San Andreas and White Wolf faults have been considered to be the major potential sources of earthquake activity.

The San Andreas is a right-lateral fault which extends nearly the length of California. It represents the boundary between the North American and Pacific tectonic plates. The present tectonic regime of the fault apparently began about 30 million years ago as a result of north-south compression. At the latitude of the spreading project site, the San Andreas bends more to an east-west direction from a northwest-southeast direction, to form a feature known as the Big Bend. Considerable stresses are exerted perpendicular to the bend by the prevalent north-south compression. The largest earthquake that occurred on the San Andreas in the vicinity of the project site was the 1957 Fort Tejon earthquake, which had a magnitude variously estimated between 7.9 and 8.25. The epicenter of this earthquake evidently lies in the Carrizo plain about 50 miles to the west of the project site.

The White Wolf fault is a northeast trending fault, which dips 70 degrees to the southeast, and lies at the base of the Tehachapi Mountains, about 20 miles southeast of the project site. During the early part of this century,

the fault was considered "inactive" until 1952 when the large Arvin-Tehachapi earthquake occurred near the southwestern end of the fault. The magnitude of this earthquake was originally estimated to be 7.7; however, recent studies (Bolt, 1978; Kanamori and Jennings, 1978) have shown that the magnitude was lower, the best estimate being 7.2. The earthquake was followed by numerous aftershocks. The sense of motion on the fault during the 1952 earthquake was a combination of displacement of either side of the fault, with the northwest side of the fault being downthrown. Based on an analysis of offset geologic formations in oil wells in the area, Stein and Thatcher (1981) concluded that earthquakes like that of 1952 could occur on the average every 170-450 years.

Potential geologic hazards are primarily those related to seismic activity originating on the White Wolf, San Andreas and other nearby faults. Greensfelder (1974) determined a maximum credible rock acceleration of about 0.3g for the site area based on earthquake of magnitude 8.25 on the San Andreas fault, 7.75 on the White Wolf fault or 6.25 on the Kern Front fault. In addition to ground shaking, a potential hazard during an earthquake is the liquefaction of soil, a phenomenon in which water saturated soil changes from a solid state to a semi-fluid mass as a result of the sudden but temporary increase in pore pressure. Soils most susceptible to liquefying are loosely compacted coarse silts and fine to medium sands. Other geologic hazards are the possibility of ground rupture and slumping, phenomena that were observed in the 1952 earthquake.

Mineral Resources

Project lands lying adjacent to the Kern River have been used in the past for sand production on a minor scale.

Kern County is the leading county in the country in the production of oil. The Bellevue Oil Field, one of the smaller fields in the county, is located in part under project lands. Four producing wells are on project lands north of the Kern River. Bellevue Oil Field was discovered in 1944 and produces from Miocene sands in a faulted anticlinal structure at depths of about 7000 feet (Troxel and Morton, 1962).

Kern River Characteristics

Since completion of Isabella Reservoir in 1952-53, Kern River runoff has averaged about 700,000 acre-feet per year at First Point which is located at the mouth of the lower canyon about one mile upstream from Beardsley Weir. Total runoff varies widely from year to year, and since 1953-54, has ranged from a low of 185,000 acre-feet in 1960-61 to an all-time high of 2,131,000 acre-feet in 1968-69. Annual runoff of Kern River at First Point, as reported by the U.S. Geological Survey, is shown in Table 3 for the period from 1953-54 to 1979-80. Large quantities of water percolate to the groundwater basin during wet years, but in many years, there is little if any Kern River flow downstream of Bakersfield because of the many upstream diversions and percolation losses. Water table elevations, however, clearly show the influence of Kern River and other recharge projects on the groundwater in the vicinity of the BMWD recharge project.

Groundwater Conditions

In the paragraphs which follow, groundwater conditions are described for a 12-mile by 12-mile study area surrounding the proposed project. This study area was selected for computer modeling of the groundwater basin as described later in this report under "Environmental Impact of Proposed Project".

Aquifer Characteristics - Geologically, units that yield major quantities of water to wells in the study area are the Tertiary and Quaternary continental deposits comprising the upper 2000 feet of strata. These deposits consist of alluvial-fan material and associated lacustrine deposits which have been accumulating in the valley since the Miocene Epoch.

The study area overlies a multiaquifer system. Sands and gravels, including an extensive gravel lentil up to 150 feet thick, occur in the upper portion of the area forming an unconfined aquifer. The unit is very permeable and yields large quantities of water to wells. This is underlain by the Corcoran clay at a depth of approximately 450 feet at the western portion of area and by

TABLE 3

KERN RIVER FLOWS AT FIRST POINT
SINCE COMPLETION OF ISABELLA DAM

(1,000 acre-feet)

<u>Water Year</u> ^{1/}	<u>Runoff</u>
1953-54	506
54-55	366
1955-56	730
56-57	473
57-58	923
58-59	418
59-60	316
1960-61	185
61-62	589
62-63	604
63-64	432
64-65	570
1965-66	502
66-67	1,401
67-68	630
68-69	2,131
69-70	733
1970-71	456
71-72	314
72-73	745
73-74	711
74-75	639
1975-76	325
76-77	214
77-78	1,227
78-79	790
79-80	<u>1,615</u>
AVERAGE	688

^{1/} October 1 to September 30

the "300 foot" clay in the east. The "300 foot" clay occurs at a depth of approximately 300 feet in the northeastern corner of the study area and dips to the southwest to a depth of approximately 500 feet in the central portion of the area (Brown, 1968). The degree of interfingering of these two clay units has not been fully determined at present. Lying underneath these clay layers is a confined sand and gravel aquifer which is additionally confined below by a clay layer at a depth of approximately 800 feet. The confined aquifer is also a good water producing zone. Sands and clays underlie the 800-foot clay layer.

Aquifer pump tests performed in this area indicate transmissivity values of 160,000 to 460,000 gallons per day per foot (Dale et al 1966). Storage coefficients of 16.9 to 19.5 percent are presented by the California Department of Water Resources (1977).

The Kern River flows diagonally across the area in a southwesterly direction, recharging the groundwater and forming a ridge in the underlying water table. As a result, the pattern of groundwater flow in both the unconfined and the confined aquifers is northwest and southeast as well as to the southwest.

Groundwater is a widely used water supply source for agricultural, municipal and industrial uses in the Bakersfield area. Water wells existing in the area of this study generally tap only the unconfined aquifer or are composite wells with screened sections in both the unconfined and confined aquifers. Pumping depressions in the groundwater table in both aquifers appear to the north of the study area near Shafter and to the south of the study area northeast of Buena Vista Lake. Recharge to the aquifers occurs through subsurface inflow, canal and river channel losses, deep percolation from irrigated lands and artificially induced spreading areas.

Water Level Fluctuations - Historically, this area has been subjected to groundwater overdraft conditions. During the 1950's and 1960's water levels decreased by more than 75 feet in some areas (Rosedale-Rio Bravo Water Storage District, 1971). Since 1978, however, a trend of increasing groundwater levels in the study area has occurred due to above average precipitation during the winter months and the operation of artificial recharge programs.

Hydrographs of water wells located within the study area are shown on Figure 4. Hydrographs of wells T30S/R26E-22P1 and 22P3 (south of the Kern River) indicate that a lowering trend occurred in both the unconfined and confined aquifers between 1961 to 1978. Readings after 1978 indicate generally rising water levels reflecting the increased recharge associated with generally wet years on the Kern River.

In the area north of the Kern River, water levels decreased steadily through the 1950's and early 1960's and then began a pattern of moderate increase in the late 1960's and 1970's as the result of a recharge program by Rosedale-Rio Bravo Water storage District. As shown on the hydrograph of well T29S/R26E-15 on Figure 4, water levels again decreased from 1975 to 1979 and then began to rise in 1979.

Seasonally, water levels are higher during the spring months and lower in the fall months. Changes of between 10 and 15 feet occur between the spring and fall readings in wells measured within the study area (Boyle Engineering Corp., 1980).

Surface Water Quality

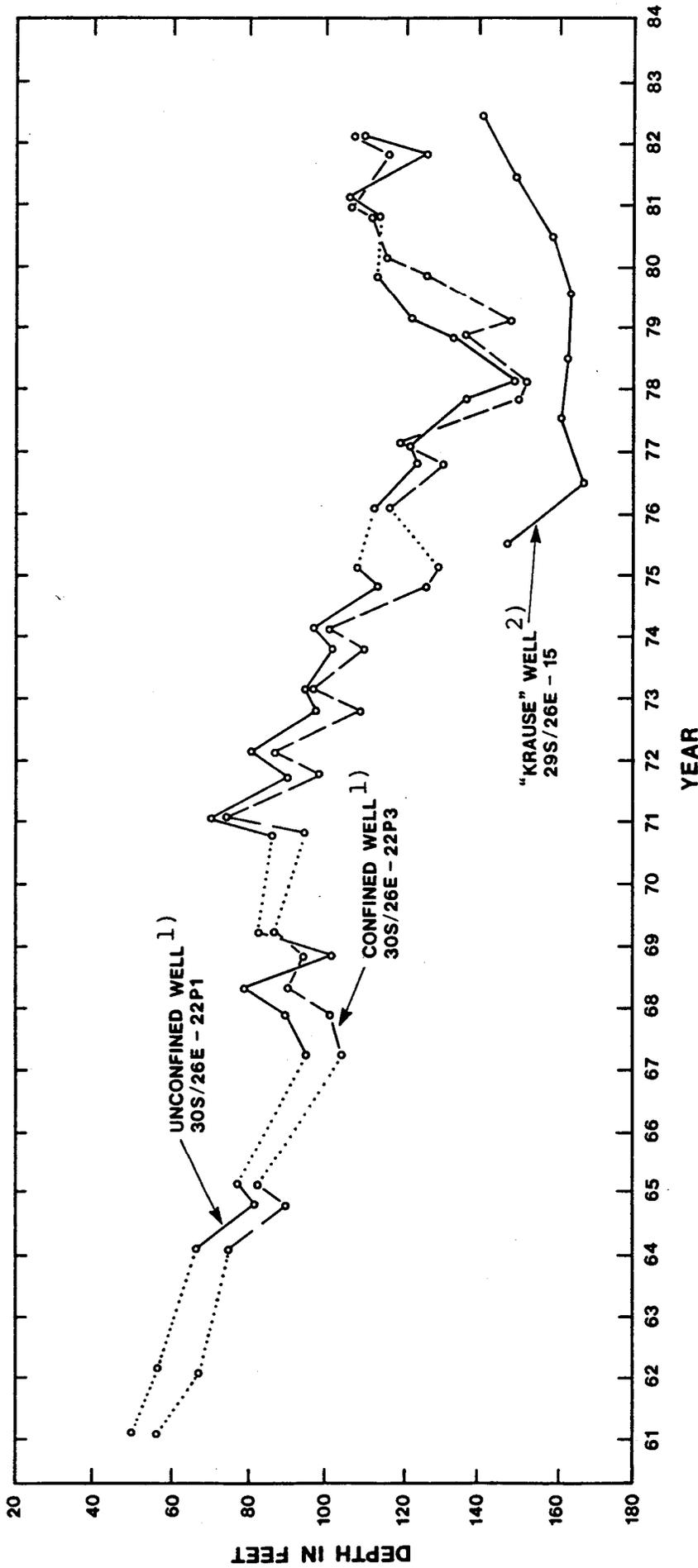
The potential sources of recharge water for the project are Kern River and the California Aqueduct. The chemical quality of waters from these three sources is illustrated in Table 4.

Water in the Kern River is very low in dissolved solids content. The quality of water from the California Aqueduct of the State Water Project is not as low in dissolved mineral concentrations, and varies more from month to month. The analysis given in Table 4 is at Check 29, near the point at which water would be diverted into the Cross Valley Canal for transport to project lands.

Groundwater Quality

Groundwater underlying the valley floor is generally of higher mineral content than the major sources of surface water; however, in most areas of the

WATER WELL HYDROGRAPHS



1) South of Kern River
SOURCE: Kern County Water Agency

2) North of Kern River
SOURCE: Rosedale-Rio Bravo Water Storage District

TABLE 4
 CHEMICAL QUALITY OF WATER FROM
 KERN RIVER AND CALIFORNIA AQUEDUCT

Constituent	Concentration (mg/l)	
	Kern River near Bakersfield March 1981 <u>1/</u>	Calif. Aqueduct at Check 29 July 1982 <u>2/</u>
Calcium	15	20
Magnesium	3	9
Sodium	16	35
Potassium	1.8	ND
Carbonate	0	0
Bicarbonate	62	57
Sulfate	14	32
Chloride	7	45
Nitrate	0.01	ND
Total Dissolved Solids	112	206
Specific Con- ductance (micromohs)	151	346
pH (units)	8.2	7.3

1/ Source: USGS Water Resources Data, California, 1981.

2/ Source: California Dept. of Water Resources, State Water Project, Report of Operations, Nov. 1982.

N.D. - No Data

basin, it is suitable for all beneficial purposes. In many areas there has been a degradation of quality in recent years.

The general quality of the groundwater near the project area is represented in Table 5 by chemical analyses of three nearby wells. Water from these wells is of good quality, with a dissolved minerals content roughly comparable to water from the State Aqueduct. A study by Kern County Water Agency (1979) indicates that the total dissolved solids (TDS) content in groundwaters underlying BMW D project lands varies from 200 to 400 parts per million (ppm), increasing in concentration toward the southwest. In general, the quality of groundwater in the basin is better in lands near the Kern River, reflecting the effects of recharge of the high quality river water; however, there are variations in quality over short distances.

Historically, the quality of groundwater in the unconfined aquifer has deteriorated in some areas of the basin. Areas with notably high concentrations of minerals in the groundwater are found on the west side of the valley and at scattered locations northwest of Bakersfield. A study by the Groundwater Pollutant Study Review Committee (1982) indicates that the areas underlain by groundwaters exceeding 500 ppm TDS increased from 578 square miles in 1958 to 1066 square miles in 1979. TDS concentrations exceeding 500 ppm were found in the Delano-McFarland, West Side-Wasco, Shafter, Buena Vista Lake-South End, and the Edison Fault areas. The areas of deteriorating groundwater quality are in many cases coincident with areas experiencing rapidly declining groundwater levels.

Biological Characteristics

Methods of Analysis

Plant life and animal populations within the project area were assessed with the following field and laboratory techniques. The purpose of this investigation was to assess the existing biological organisms within the BMW D percolation site and to assess the effects of the change in land use on the natural resources.

TABLE 5
GROUNDWATER QUALITY
FROM WELLS NEAR PROJECT SITE

	Concentration (mg/l) *		
	<u>29S/26E-32N03</u>	<u>29S/27E-35A02</u>	<u>30S/26E-29M01</u>
Calcium	18	22	4
Magnesium	3.5	2.0	0.2
Sodium	18	17	75
Potassium	1.0	2.1	0.6
Carbonate	0	0.2	0
Bicarbonate	81	90	67
Sulfate	9.0	14	6.0
Chloride	5.2	11	76
Nitrate	1.3	0	0.5
Total Hardness (non-carbonate)	59	64	11
Total Dissolved Solids	96	132	197
Specific Conductance (micromohs)	226	200	360
pH (units)	7.9	7.5	8.0

* Unless otherwise noted.

Reference: California Department of Water Resources, Bulletin
No. 130-75, Vol. IV, 1975.

Location of wells from project site:

29S/26E-32N03 - 3 miles west
29S/27E-35A02 - 6 miles east
30S/26E-29M01 - 5 miles southwest

Transects of the vegetation were completed on both the north and south bank of the Kern River (Figures 5 and 6). Each transect sample was 500 meters in length and one meter wide, and the percentages of plant cover types were recorded at each 100 meter interval. Individual plant species also were collected along the transect route in order to make accurate plant identifications by later comparisons with a reference herbarium. At the time of the field visit there was an unusual amount of standing water present within the project area, restricting freedom of movement over the areas of lower elevation.

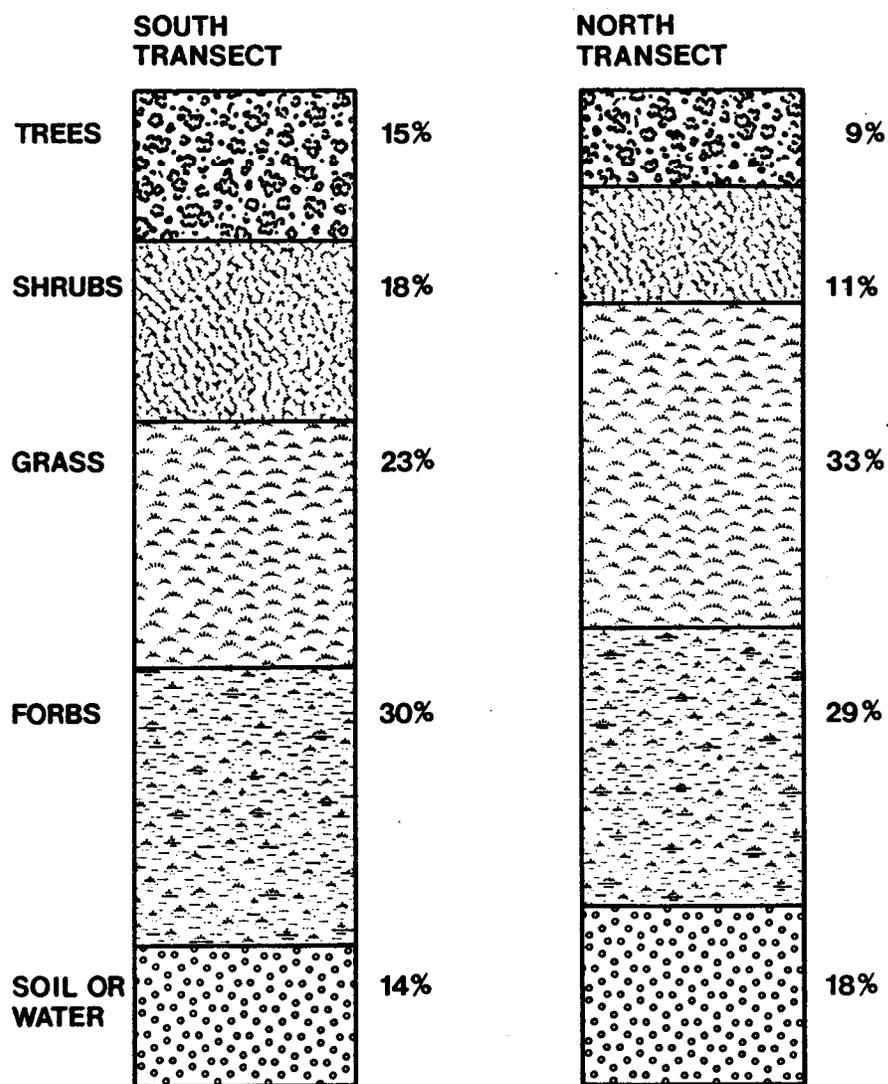
Field records provided the most important source of site data about the birds, mammals, reptiles, amphibians and fish observed during the investigation of March and April, 1983. The visible movements of mammals, birds, and other vertebrates were noted and some indication of the relative abundance of the observed animals was included.

Indirect evidence was additionally gathered during the field studies. Animal burrow systems, animal scat, small bones, feathers, and bird nests were all useful indicators of the presence of nocturnal, migratory and transient species within the project area.

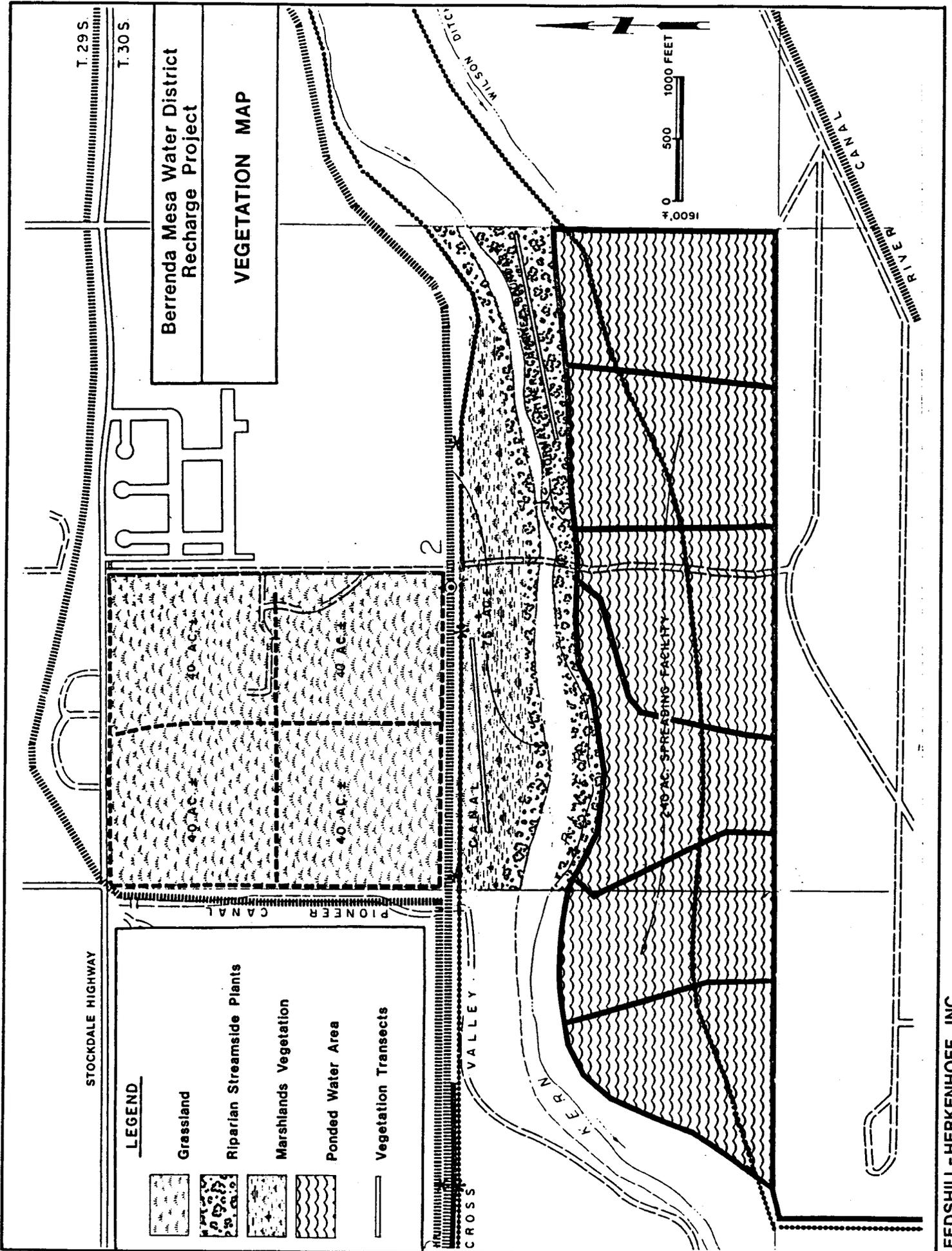
A literature search helped in the effort to include the work of other scientists that have carried out field investigations during the summer, fall, and winter months. The atypical rainfall during the spring of 1983, which doubled the normal levels, made the reference work of other years and other seasons all the more appropriate.

General Ecological Features

The area of benefit within this project lies along both sides of the Kern River, west of the Stockdale Bridge at elevations of 243 to 264 feet above sea level. The boundaries of the percolation basin site are shown in Figure 2, and include a natural riparian fringe of habitat along the river banks as well as a ponding and percolation region south of the channel and additional cultivated land north of the channel. This riparian habitat is one of the most threatened



**VEGETATION TYPES ON
TWO 500-METER TRANSECTS
WITHIN THE BMWD PROJECT SITE**



parts of California's diverse ecosystems, with as little as one percent of the original riverbank riparian habitat still found in the state. The cottonwoods, willows, berries and a variety of woody shrubs that line and stabilize the riverbanks require high soil moisture during most of the year.

Vegetation

As shown on Figure 5, valley grassland habitat constitute the most dominant part of the plant cover in the project, with 33 percent of the 500-meter transect sample along the north bank found to be grass covered. Individual grass species present are mostly non-native, and as indicated in Table 6, there are five imported grasses and only four native species. A history of disturbance by grazing, oil field operations, and woodcutting all favor imported plants.

Saltbush brushland has been a widespread vegetation type in recent years along the slightly elevated river terraces. Development of intensive agricultural lands on both sides of the Kern River has reduced the extent of the Atriplex shrubs, and Prosopis mesquite trees that formed the valley chaparral. The rare and endangered San Joaquin Leopard Lizard is linked with the Atriplex brushland zones, but no evidence of this lizard population was found during the colder months of March and April, 1983.

Broadleaf forb plants are excellent indicator species of the nature of the land use patterns in a given site. Along the route of the two 500-meter long sample transects some 30 percent of the land was covered by broadleaf forbs. Had the transect been located in the northern portion of the project as shown in Figure 6, the result would have produced 100 percent forb cover with cotton Gossypinum hirsutum, constituting the dominant plant on the area. The list of 28 forbs includes seven non-native imports. The fact that one-fourth of the forbs are non-native verifies the seriously disturbed nature of the project vegetation. The two transects were located in riverbank zones which were riparian wooded and reasonably dry in order to walk the routes of the sample. Field work on the vegetation sampling was carried out between March 18, 1983 and August 27, 1983. The majority of the project area shown in the vegetation map (Figure 6) was under

TABLE 6

VEGETATION OF THE PROJECT SITE

DATA SOURCE OF PLANT IDENTIFICATION: HV. = Herbarium Verified
 FS. = Field Sighting
 Lit. = Literature Reference

PLANT SOURCES: As. = Asia Eu. = European
 N. = Native So.Am. = South America

			<u>Plant Source</u>	<u>Data Source</u>
TREES	Black Willow	<u>Salix goodingii</u>	N.	FS.
	Fremont Cottonwood	<u>Populus fremontii</u>	N.	HV.
	Tree Tobacco	<u>Nicotiana glauca</u>	So. Am.	FS.
	Wild Elderberry	<u>Sambucus mexicanus</u>	N.	HV.
	Buttonwillow	<u>Cephalanthus occidentalis</u>	N.	FS.
SHRUBS	Common Saltbush	<u>Atriplex polycarpa</u>	N.	HV.
	Horehound	<u>Marrubium vulgare</u>	N.	FS.
	Baccharis	<u>Baccharis emoryi</u>	N.	FS.
	Common Nettle	<u>Urtica holoserica</u>	N.	FS.
	Bladder Pod	<u>Isomeris arborea</u>	N.	Lit.
GRASS	Slender Wild Oat	<u>Avena barbata</u>	As.	HV.
	Saltgrass	<u>Distichlis glomerata</u>	N.	FS.
	Soft Chess Grass	<u>Bromus mollis</u>	Eu.	FS.
	Red Brome Grass	<u>Bromus rubens</u>	Eu.	FS.
	Foxtail Fescue	<u>Festuca megalura</u>	N.	FS.
	Ripgut Brome Grass	<u>Bromus rigidus</u>	Eu.	FS.
	Arabian Grass	<u>Schismus arabicus</u>	As.	HV.
	Alkali Rye Grass	<u>Elymus triticoides</u>	N.	FS.
	Common Tule	<u>Scirpus acutus</u>	N.	FS.
	Johnson Grass	<u>Holcus halepensis</u>	Eu.	HV.
	Fern Duckweed	<u>Axolla filiculoides</u>	N.	FS.
	Green Duckweed	<u>Lemna minor</u>	Eu.	FS.
FORBS OR BROADLEAF PLANTS	Orange Fiddleneck	<u>Amsinckia menzeisii</u>	N.	HV.
	Suncups	<u>Camissonia campestris</u>	N.	HV.
	California Mugwort	<u>Artemisia douglassiana</u>	N.	FS.
	Telegraph Weed	<u>Heterotheca grandiflora</u>	N.	FS.
	Baltic Rush	<u>Juncus balticus</u>	As.	HV.
	Yellow Monkey Flower	<u>Mimulus guttatus</u>	N.	FS.
	Curly Dock	<u>Rumex salicifolium</u>	N.	FS.
	Cocklebur	<u>Xanthium strumarium</u>	Eu.	FS.
	Shepherds Purse	<u>Capsella bursa-pastoris</u>	Eu.	FS.
	Red-stem Filaree	<u>Erodium cicutarium</u>	Eu.	FS.

TABLE 6
VEGETATION OF THE PROJECT SITE (Contd.)

			<u>Plant Source</u>	<u>Data Source</u>
FORBS OR BROADLEAF PLANTS (Contd.)	Goldfields	<u>Lasthenia chrysostoma</u>	N.	FS.
	Bicolor Lupine	<u>Lupinus bicolor</u>	N.	HV.
	White Cheezweed	<u>Malva parviflora</u>	Eu.	FS.
	Bur Clover	<u>Medicago hispida</u>	N.	FS.
	Owl's Clover	<u>Orthocarpus purpurascens</u>	N.	FS.
	Hedge Mustard	<u>Sisymbrium officinale</u>	Eu.	FS.
	Russian Thistle	<u>Salsola kali</u>	As.	FS.
	Bird's Eye Gilia	<u>Gilia tricolor</u>	N.	FS.
	Pineapple Weed	<u>Matricaria matricarioides</u>	N.	FS.
	Groundsel	<u>Senecio vulgaris</u>	N.	FS.
	Common Spikerush	<u>Eleocharis macrostachys</u>	N.	FS.
	Wild Sunflower	<u>Helianthus annuus</u>	N.	FS.
	Spotted Spurge	<u>Euphorbia ocellata</u>	N.	FS.
	Jimson Weed	<u>Datura meteloides</u>	N.	HV.
	Knot Weed	<u>Polygonum lapathifolium</u>	N.	HV.
	Sow Thistle	<u>Sonchus oleraceus</u>	N.	FS.
Hoover Star Flower *	<u>Eriastrum hooveri</u>	N.	Lit.	
Slough Thistle *	<u>Cirsium crassicaule</u>	N.	Lit.	

* Protected and Rare plant species reported by California Native Plant Society.

water or planted in cotton, consequently the plant list shown is not truly representative of the majority of the total site area, but only of the region close to the Kern River channel.

Denuded soil and open water areas along the routes of the sample transects were only 18 percent of the one meter wide routes. Much of the exposed soil was caused by the access roads in the area as well as the trails of the off-road recreational vehicles that have modified the vegetation and the soil surface during recent years along the banks of the Kern River. Dike construction, percolation basin construction, cement-lined canal development, and intensive cotton farming are all factors that have removed much of the typical tree and shrub cover such as the mesquite Prosopis juliflora and saltbrush Atriplex polycarpa that formed the river terrace dryland habitat in past years. Such habitat is critical for such animals of the central San Joaquin valley as the blunt-nosed leopard lizard and the San Joaquin kit fox.

Wildlife

One of the most valuable and threatened habitats in California is the arboreal fringe along the major rivers, known as the riparian zone. A recently published federal report by the U.S. Fish and Wildlife Service cites the important habitats for fish and wildlife in California. The report states that the riparian trees and streambank vegetation have been reduced to only one percent of the former coverage. Some of the reasons for protecting the remaining riparian fringe habitat is the fact that it provides normal migration routes for wildlife in the state. Waterfowl such as ducks, geese, shore birds and some of the threatened raptors including the marsh hawk, Coopers hawk, osprey, and the bald eagle all require the safety and nesting sites provided by this specific riparian habitat type.

Grassland wildlife species may well be the most modified in the ponding season of the early spring months due to the loss of much of the grassy terrain during the time that the grasslands are covered by water. Such species as the western meadowlark Sturnella neglecta, horned lark Eremophila alpestris and

mourning dove, Zeniadura macroura will likely seek adjacent feeding and nesting areas during the years of very heavy runoff levels.

Brushland wildlife occupy the brushland areas within the project and are cited in Tables 7 and 8. The shrub areas form the habitat for the California quail, with quailbush Atriplex lentiformis as one of the denser brushland shrub types. Brushland habitat zones on the floor of the San Joaquin valley have been reduced and modified yearly by such commercial activities as oil field operations, row-crop farming, livestock grazing, access roads, gravel mining, and off-road vehicle recreation. Brushland area reduction causes an accompanying reduction of such wildlife as the Audubon cottontail, marsh wren, roadrunner, phainopepla, chaparral mouse, and the whiptail lizard.

Fish and amphibians inhabiting the Kern River area are listed in Table 9.

Rare and Endangered Wildlife

Rare and endangered wildlife which have habitat zones within the margins of the BMWV project area on the banks of the Kern River, include the nocturnal kit fox and the blunt-nosed leopard lizard. Summer visits to the region in August and September, 1983, did not find any evidence of populations of these two vertebrates currently present within the area. An evening of night light spotting was carried out with Mr. Bill Asserson of the California Department of Fish and Game between 7:30 and 10:40 PM, on June 18 of 1983. Mr. Asserson routinely tours three circuits of this part of the San Joaquin Valley in order to develop an on-going count of such endangered organisms as the kit fox or some of the rare species of kangaroo rats that are only active at night. Although Canadian beaver, muskrat, and badger were observed in the sweeping beams of the spotting lights, as well as a number of rodents and lagomorphs (rabbits), no kit fox activity was observed. Furthermore, the construction of the percolation basins, dikes, canals, and cotton field discing all served to disturb or modify the dryland parts of the site so that no burrow systems of the kit fox or the large leopard lizard were seen in the field surveys.

TABLE 7

BIRDS OF THE PROJECT AREA

A = Abundant, C = Common, O = Occasional, R = Rare

<u>Common Name</u>	<u>Scientific Name</u>	
Lesser Scaup Duck *	<u>Athya affinis</u>	O
Mallard Duck *	<u>Anas platyrhynchos</u>	C
Pied-billed Grebe	<u>Polymbus podiceps</u>	O
Black-crowned Night Heron	<u>Nycticorax nycticorax</u>	C
American Coot Mudhen	<u>Fulica americana</u>	C
Great Blue Heron	<u>Ardea herodias</u>	C
Spotted Sandpiper	<u>Actitis macularia</u>	O
Greater Yellowlegs	<u>Totanus melanoleucus</u>	O
Killdeer	<u>Charadrius vociferus</u>	C
Harrier Marsh Hawk *	<u>Circus cyaneus</u>	O
Cooper's Hawk *	<u>Accipiter cooperi</u>	R
Red-tailed Hawk	<u>Buteo jamaicensis</u>	C
Sparrow Hawk Kestrel	<u>Falco sparverius</u>	C
Roadrunner	<u>Geococcyx californicus</u>	O
Barn Owl	<u>Tyto alba</u>	C
Mourning Dove *	<u>Zenaidura macroura</u>	C
California Quail *	<u>Lophortyx californicus</u>	C
Loggerhead Shrike	<u>Lanius ludovicianus</u>	C
Anna Hummingbird	<u>Calypte anna</u>	C
California Scrub Jay	<u>Aphelocoma coerulescens</u>	C
Western Kingbird	<u>Tyrannus verticalis</u>	O
Black Phoebe	<u>Sayornis migricans</u>	O
Phainopepla	<u>Phainopepla nitens</u>	O
Nuttall Woodpecker	<u>Dendrocopos nuttallii</u>	O
Horned Lark	<u>Eremophila alpestris</u>	A
Western Meadowlark	<u>Sturnella neglecta</u>	C
Cliff Swallow	<u>Petrochelidon pyrrhonota</u>	C
Brewer Blackbird	<u>Euphagus cyanocephalus</u>	C
Yellow-rumped Warbler	<u>Dendroica auduboni</u>	C
Western Robin	<u>Turdus migratorius</u>	C
Long-billed Marsh Wren	<u>Telmatodytes palustris</u>	O
Northern Junco	<u>Junco oreganus</u>	C
White Crowned Sparrow	<u>Zonotrichia leucophrys</u>	C
House Finch	<u>Carpodacus mexicanus</u>	A
American Egret	<u>Casmerodius albus</u>	O
Black-necked Stilt	<u>Himantopus mexicanus</u>	O
Osprey *	<u>Pandion haliaetus</u>	O
Ring-necked Pheasant	<u>Phasianus colchicus</u>	O
Burrowing Owl *	<u>Athene cunicularia</u>	R

TABLE 7
BIRDS OF THE PROJECT AREA (Contd.)

<u>Common Name</u>	<u>Scientific Name</u>	
Brown Towhee	<u>Pipilo fuscus</u>	0
Golden Crowned Sparrow	<u>Zonotrichia atricapilla</u>	0
Song Sparrow	<u>Melospiza melodia</u>	0
Red-winged Blackbird	<u>Agelaius phoeniceus</u>	C
Lark Sparrow	<u>Chondestes grammacus</u>	0

* Protected species by Federal Fish and Wildlife Service.

TABLE 8

MAMMALS AND REPTILES OF THE PROJECT AREA

A = Abundant, C = Common, O = Occasional, R = Rare

<u>Common Name</u>	<u>Scientific Name</u>	
MAMMALS		
Aubudon Cottontail *	<u>Sylvilagus audubonii</u>	O
Beechey Ground Squirrel	<u>Citellus beecheyi</u>	C
Deer Mouse	<u>Peromyscus maniculatus</u>	A
Chaparral Mouse	<u>Peromyscus truei</u>	O
Pocket Gopher	<u>Thomomys bottae</u>	A
House Mouse	<u>Mus musculus</u>	C
Muskrat	<u>Ondatra zibethica</u>	O
Common Opossum	<u>Didelphis marsupialis</u>	O
Free-tailed Bat	<u>Tadarida brasiliensis</u>	C
Long-tailed Weasel	<u>Mustela frenata</u>	O
Striped Skunk	<u>Mephitis mephitis</u>	O
Coyote	<u>Canis latrans</u>	O
Blacktailed Jackrabbit *	<u>Lepus californicus</u>	O
Canadian Beaver	<u>Castor canadensis</u>	R
San Joaquin Kit Fox	<u>Vulpes macrotis var. mutica</u>	R
REPTILES		
California Whiptail Lizard	<u>Cnemidophorus tigris</u>	O
Side-blotched Lizard	<u>Uta stansburiana</u>	C
Western Fence Lizard	<u>Sceloporus occidentalis</u>	A
Common Kingsnake	<u>Lampropeltis getulus</u>	O
California Racer	<u>Masticophis lateralis</u>	O
Aquatic Garter Snake	<u>Thamnophis couchi</u>	R
Gopher Snake	<u>Pituophis melanoleucus</u>	O
Blunt nosed Leopard Lizard **	<u>Gambelia silus</u>	R
Western Pond Turtle	<u>Clemmys marmorata</u>	O

* Protected animal under the California Department of Fish and Game.

** Protected animal under California Department of Fish and Game and the Federal Fish and Wildlife Service.

TABLE 9

AMPHIBIANS AND FISH OF THE KERN RIVER PROJECT AREA

A = Abundant, C = Common, O = Occasional, R = Rare

<u>Common Name</u>	<u>Scientific Name</u>	
AMPHIBIA		
Spadefoot Toad	<u>Scaphiopus hammondi</u>	O
Bullfrog	<u>Rana catesbeiana</u>	A
Western Toad	<u>Bufo boreus</u>	C
Pacific Tree Frog	<u>Hyla regilla</u>	C
Pacific Newt	<u>Taricha torosus</u>	O
FISH		
Mosquito	<u>Gambusia affinis</u>	A
Hardhead	<u>Mylopharodon conocephalus</u>	O
Bluegill Perch	<u>Leopomis macrochirus</u>	A
White Catfish	<u>Ictalurus catus</u>	C
Carp	<u>Cyprinus carpio</u>	O
Small Mouth Bass	<u>Micropterus dolomieu</u>	O

Protected species of game birds and animals constitute the majority of protected species on the project. Two ducks, the mallard and the lesser scaup duck, are protected except during designated open seasons. Two upland game species, the California quail and the mourning dove, are also present within the site, but in view of the grading and removal of the saltbrush Atriplex and mesquite Prosopis, woody shrubs on both the entire northern as well as the southern ponding regions of the site, the remaining habitat for quail and doves is limited to the narrow riparian strips of plant cover along the river banks.

Protected raptors which are singled out by the U.S. Fish and Wildlife Service include the osprey, the burrowing owl, and the marsh hawk and Cooper hawk. These predatory species form a significant part of the food chain and have recently been given protected status by wildlife managers and federal agencies.

Cultural Features

Population

According to the 1980 United States census, there were 403,000 permanent residents of Kern County, of whom 106,000 or 26 percent resided in the City of Bakersfield. The urban Bakersfield area has a population of about 244,000. The Kern County Planning Commission (1982) projects the total county population to increase to 600,000 by the year 2000, with future growth expected to be about equally divided between incorporated and unincorporated areas.

A housing development (Figure 2) has been constructed recently on lands adjacent to the project site. As of October 1983 the housing development consisted of 57 single family houses for which permits have been issued. A total of 413 lots are proposed on 148.25 acres with a resulting density of 2.79 dwelling units per acre. The maximum projected population of the subdivision is about 1,360, assuming 3.3 persons per dwelling unit. There are also scattered subdivisions in nearby unincorporated areas north and northeast of project lands.

Land Use

The Kern County General Plan (1982) designates project lands lying south of the Kern River as being intensive agriculture, with a flood hazard physical constraint. The General Plan includes operation of groundwater recharge areas as being one of the compatible uses of agricultural lands. Project lands north of the river are within the City of Bakersfield and are zoned for suburban residential development. The Bakersfield Metropolitan Area General Plan designates land use in most of this area to be low density residential. Use of this land for groundwater recharge ponds will require an amendment to the General Plan, rezoning, and conditional use permit review of the project. Land within the Kern River floodplain is designated as open space.

Project lands are presently not farmed, but in the recent past crops such as cotton were grown on much of the acreage. Several producing oil wells are located on project lands north of the river. Lands surrounding the project are largely agricultural, with the exception of the previously noted subdivision. The City of Bakersfield operates an extensive groundwater recharge program on 2800 acres of land adjacent to the Kern River and downstream from the proposed BMWD project. The City presently uses a small portion of this area for spreading but proposes to develop 14 separate spreading basins utilizing 1,537 acres of this property (Stetson Engineers, 1983). The program is currently under assessment. The Kern County Water Agency operates a groundwater recharge program upstream from the proposed BMWD project. The Cross Valley Canal cuts across project lands north of the river. Stockdale Highway passes along the north edge of the project and several unpaved roadways provide access to project lands. The Kern County General Plan (1982) indicates that Renfro Road; which borders the NW fourth of Section 2, may be extended through the project area in the SW fourth Section 2.

Canals

There are many canals in the southern San Joaquin Valley which have been constructed to distribute water from the Kern River, the State Water Project

and the Central Valley Project (Figure 1). The largest and most prominent of these is the California Aqueduct, the primary conveyance facility of the State Water Project. Water is pumped into the California Aqueduct from the Sacramento Delta. The aqueduct then transports such water southward for use in the San Joaquin Valley and southern California. In times of flood runoff, surplus water from the Kern River can be diverted into the aqueduct through the Kern River-California Aqueduct Intertie located near Tupman.

The Friant-Kern Canal is a unit of the Central Valley Project and is operated by the U.S. Bureau of Reclamation. Water from the Friant-Kern Canal can be released at its terminus into the Kern River upstream of the proposed project area.

The Cross Valley Canal was constructed in 1974 to convey water from the California Aqueduct on the west side of the San Joaquin Valley to the vicinity of Bakersfield on the east side. The Cross Valley Canal and its associated facilities supply supplemental water for several agricultural districts and provides a firm water supply for the urban Bakersfield area.

In addition to the Cross Valley Canal, other canals close to BMWD project lands are the Pioneer Canal and the River Canal, both of which transport water diverted from the Kern River upstream of the project.

Recreation

There are presently no recreational facilities in the project area. Possible recreational activities might include wildlife observation, hiking, or horseback riding along the riverbank; otherwise, there is little opportunity for recreation on project lands.

Kern County Planning Department, in cooperation with the City of Bakersfield, is currently preparing a Kern River Plan which will address open space and conservation concerns for the floodplain area. The northern boundary of the floodplain in the project area will probably be defined by the location of the Cross Valley Canal.

Historical and Archaeological Features

There are no known sites of historical or archaeological significance within the project area. A site records search and literature review (Bakersfield College, 1983) indicated no recorded archaeological sites within the project area. Five or more archaeological sites, previously recorded, exist within a three-mile radius of the project boundary. The archaeological records search is included as Appendix A.

ENVIRONMENTAL IMPACT OF PROPOSED PROJECT

Impact During Construction

Construction of levees, diversion works and control structures will cause increased noise and dust from operation of heavy equipment. Since the southern 240 acres of project land are already developed for spreading, the area that will be most affected will be confined to the northern 160 acres of the site. The noise and dust will affect mainly the construction workers, except in the area adjacent to the housing development near Stockdale Highway, where the residents could be adversely affected. This area is downwind of prevailing winds. The estimated duration of construction impacts is expected to be about 10 days.

Alteration of Habitat

The proposed project will result in altering the habitat on parts of the project land. Riparian habitat will be retained on both sides of the Kern River, including a portion of the 75-acre parcel on the north side of the river that has not undergone prior development as agricultural land (Figure 2). With time, this area may be expected to revert to an even more natural grassland and riparian habitat than it presently is.

The 240-acre parcel south of the river (Figure 2) is presently developed as a spreading pond area, and continued use as such will provide habitat for waterfowl when water is ponded there. A similar alteration of habitat may be expected in the northern 160-acre parcel, previously used for farming, if that area is developed as spreading basins. Species which would likely benefit include the federally protected marsh hawk.

In Table 10 the impact of the project is indicated on those species listed both by the U.S. Fish and Wildlife Service and the California Department of Fish and Game as either a threatened and depleted species or as protected game species subject to limits of the open season regional fish and game regulations.

TABLE 10
SUMMARY OF THE RARE, ENDANGERED OR PROTECTED ORGANISMS ON THE SITE

SCIENTIFIC NAME COMMON NAME	PROTECTION STATUS	VULNERABILITY ON THE BERRENDA MESA SITE
<u>Athene cunicularia</u> Burrowing Owl	Federal Special Concern	Existing farming and basin construction have reduced habitat.
<u>Accipiter cooperi</u> Cooper Hawk	Federal Special Concern	Some habitat loss on percolation basins.
<u>Circus cyaneus</u> Marsh Hawk Harrier	Federal Special Concern	Habitat enhanced by increased marshlands.
<u>Pandion haliaetus</u> Osprey	Federal Special Concern	Habitat enhanced by percolation basins.
<u>Gambelia silus</u> Blunt Nosed Leopard Lizard	Rare Endangered State & Federal	Most dryland habitat has been modified by current land uses.
<u>Vulpes macrotis var. mutica</u> San Joaquin Kit Fox	Rare Endangered State & Federal	Dryland habitat has been altered by farming and percolation basins.
<u>Lophortyx californicus</u> California Quail	Protected by State game laws	Increased percolation ponds decreases the quail habitat.
<u>Zeniadura macroura</u> Mourning Dove	Protected by State game laws	Some habitat loss if basins are filled.
<u>Athya affinis</u> Lesser Scaup Duck	Protected Federal game regulations	Increased habitat by percolation basins.
<u>Anas platyrhynchos</u> Mallard Duck	Protected Federal game laws	Duck habitat increased in ponding season.
<u>Sylvilagus audubonii</u> Audubon Cottontail	Protected State & Federal game law	Some habitat loss in ponding season.
<u>Lepus californicus</u> Black Tailed Jackrabbit	Protected State & Federal game law	Some loss of habitat during the ponding season of the year.
<u>Eriastrum hooveri</u> Hoover Star Flower	Protected State Resource Dept.	This rare plant grows only in wet years in the valley, none was found.
<u>Cirsium crassicaule</u> Slough Thistle	Protected State Resource Dept.	This riverbank rare plant was not found on this modified site.

A maintenance program is planned for rodent control, mosquito abatement and desiltation such that wildlife breeding periods are minimally disrupted.

Change in Land Use

Most of the project land has been used in the past for agriculture. An area of about 75 acres adjacent to the Kern River has not been farmed and a portion of it will be retained in its present native state. No specific plan has been developed as yet for this acreage. Construction and operation of the project will result in changing the remaining lands from their previous agricultural use to spreading basins.

Visual Impacts

The presence of ponded water in the spreading basins will greatly change the appearance of the area. When no water is being spread, the land will have an appearance similar to the surrounding farmed areas. Levees will be constructed with soils from adjacent areas and because they will be very low, they will have little visual impact when no water is being spread. The basins will be seeded with grasses or other deep rooted herbaceous plants to facilitate recharge, thus also enhancing the appearance of the area. From time to time it will probably be necessary to recondition the basins, possibly removing the vegetation in the process.

Flooding and Erosion

The project would not result in any flood hazard greater than presently exists. A portion of project lands south of the Cross Valley Canal are within the State Reclamation Board's Kern River Designated Floodway, and during extreme flood flows the levee along the south bank of the river would be breached and the lands flooded. Orthophoto maps of the floodway are presented in Appendix B. The photos were taken prior to development of the existing spreading facilities on BMWD lands. An encroachment permit from Kern County Water Agency and review by the State Reclamation Board is required for construction within the designated floodway.

A portion of the project is also within the secondary floodplain. Flood flows on the north side of the river will not be restricted by levees and may be flooded. Project lands lying north of the Cross Valley Canal are outside the floodplain.

Geologic Hazards

No soil study has been made of the project area but it appears possible that there is a potential of liquefaction, provided there is a uniform grain size and the relative densities of the soil are sufficiently low. The present water table under project lands is between 50 and 100 feet below ground surface. The proposed project would raise water levels and would also result in saturated soil conditions in the recharge mound above the water table. This condition could potentially contribute to liquefaction hazard in the event of a strong earthquake. Liquefaction poses little hazard to project lands but could affect houses in the nearby development and possibly the Cross Valley Canal if measures are not taken to mitigate this potential. There may be an existing high water table under the housing development due to percolation from the nearby unlined Pioneer Canal.

In other areas the extraction of groundwater has been known to result in land subsidence due to reduced pore pressures and the resulting consolidation of clay layers overlying a confined aquifer. This phenomenon is not expected to occur as a result of this project because water will not be pumped from the confined aquifer and there is little clay in the upper unconfined aquifer.

Other geologic hazards include the possibility of ground rupture and slumping in the event of an earthquake, but the probability of such occurrences is considered remote due to the distance of the site from any known active faults. Seiches (oscillating wave motion) could occur in the spreading ponds during an earthquake but the shallow depth of water in the ponds precludes wave heights sufficient to cause any damage to the levees. The levees could be breached by seismic settlement or differential compaction during an earthquake.

Changes in Groundwater Regime

Operation of the groundwater recharge and extraction project would result in changes in the flow and elevation of the groundwater regime. To determine the magnitude and geographical extent of these changes, a computer model was developed to simulate groundwater conditions as they would have been over a 31-year historical period, had the recharge and extraction program been in operation during that time. In the following paragraphs the various parameters and assumptions that were used in the model are described, followed by a discussion of the results.

Choice of Model

To simulate the aquifer, a two-dimensional finite-difference model developed by the U.S. Geological Survey was applied to a 10-mile by 11-mile area with the recharge project in the center. The assumption that the effects on the aquifer are limited to a radius of approximately five miles was to be confirmed by the model itself. The initial estimate for the zone of influence was derived from water table elevation maps.

The effects of pumping and recharge were assumed to be limited to the unconfined part of the aquifer above the Corcoran clay.

Initial elevations of the water table in the unconfined aquifer were obtained from Kern County Water Agency (1981). In the study area there is a groundwater ridge along the Kern River, indicating a flow of groundwater away from the river and downstream towards the center of the valley.

Calibration

The objective of calibration is to find a set of aquifer parameters and inflow/outflow conditions that would maintain the initial water table configuration in equilibrium (under static conditions). This objective was met with the following model grid spacing, boundary conditions, hydraulic conductivity, specific yield and recharge conditions.

Grid Spacing - The grid spacing should be small where there are steep gradients in the water table and where detailed information is needed. Accordingly, grid elements were quarter mile squares near the recharge and extraction areas, grading out to one mile squares at the fringes of the study area. Grid spacing is illustrated on Plate 2. The grid shown covers a 10-mile by 11-mile area.

Boundary Conditions - The study area was provided with constant head boundaries. Depending on whether the water level adjacent to the constant head boundary is higher or lower than the level at the boundary, water will either leave or enter the simulated area.

Inflow occurs on the eastern boundary in the vicinity of the point where Kern River enters the simulated zone. This is a major recharge area characterized by steep groundwater gradients which are relatively unaffected by the comparatively minor water table fluctuations in the simulation. Inflow also occurs as natural and artificial recharge on lands within the study area. Accordingly, recharge nodes were introduced to maintain a steady water table. The rate of recharge was modified in proportion to the size of the grid element and the permeability of the ground in that grid.

Outflow through the constant head boundary occurs at much lower rates than inflow but over most of the remaining model periphery. If intensive recharging is done over a prolonged period of time, the recharge mound will spread to the boundary and increase the discharge through the boundary. The use of a constant head boundary assumes that the outflow through the boundary drains away unrestricted. In reality there will be a rise in water levels outside the boundary. Thus the model tends to overestimate the outflow.

Specific Yield - The Kern County groundwater model (Calif. Department of Water Resources, 1977) has four nodes covering the area simulated here. The specific yields at these four nodes (16.9, 18.1, 18.6, 19.5 percent) were averaged to a uniform rate of 18.3 percent for the model area.

Hydraulic Conductivity - The hydraulic conductivity used in the model ranges from 0.003 to 0.024 ft./sec. (1,722 to 13,776 gpd/ft²). The higher permeabilities are concentrated near Kern River and the lower permeabilities on the fringes of the study area. This configuration stabilizes the groundwater ridge along Kern River. The study area is located on the alluvial fan, where highly permeable gravel strata are found near the main waterway and finer deposits with low permeabilities are encountered away from the river and on the fringes of the fan.

Steady State Conditions - With the foregoing conditions and aquifer characteristics, it was possible to create a steady state condition with water level contours as shown on Plate 3. These steady state water levels were compared with water levels in the study area during recent years (Figure 7). The groundwater levels underlying the Kern River vary with wet and dry years and in response to seasonal pumping patterns. After periods of extreme spring runoff, a very pronounced mound is created by the recharge from the Kern River channel. In dry years this mound can lower by as much as 50 feet.

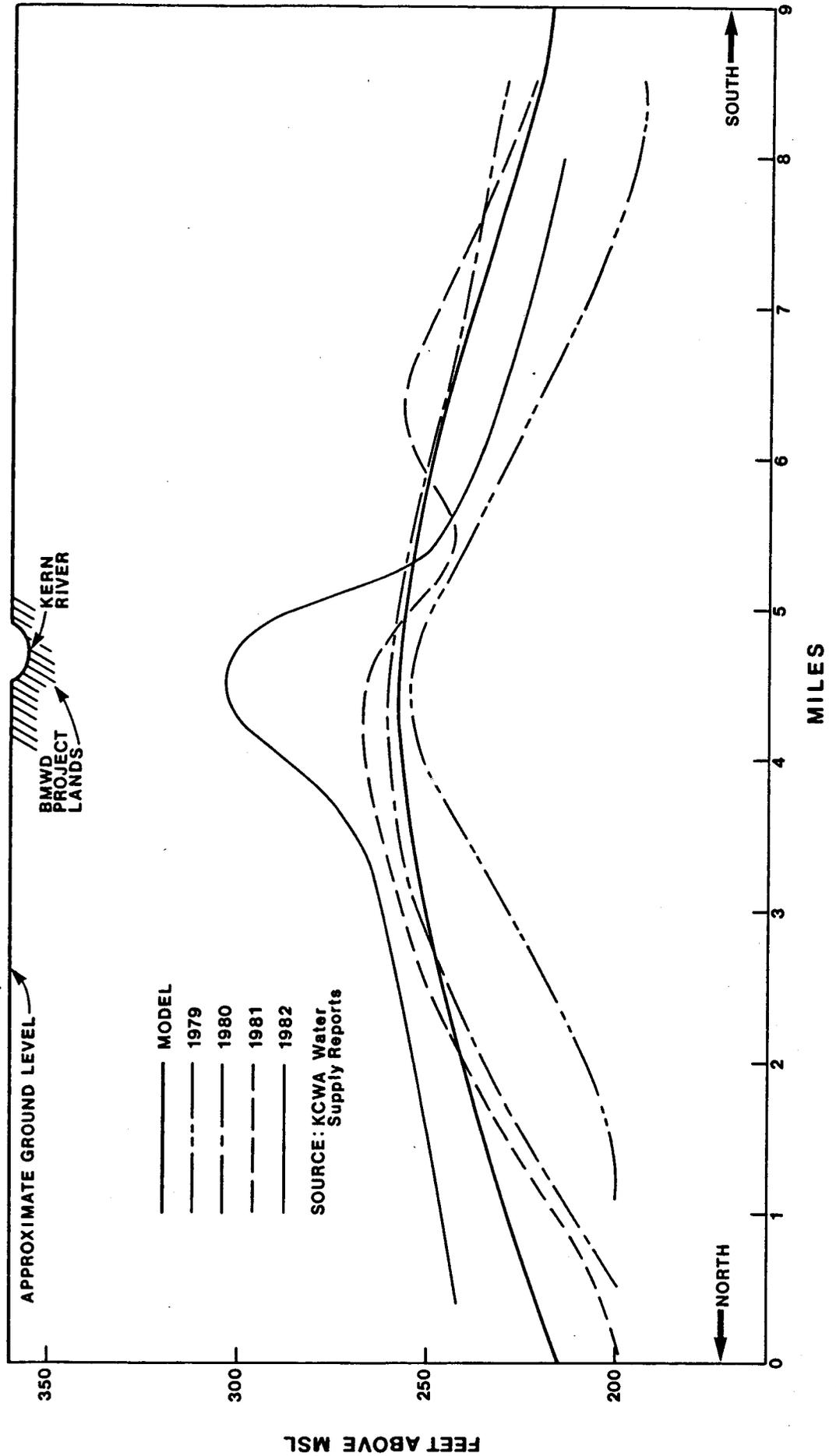
Pumping for irrigation during the summer months in the areas north and south of the study area results in considerably steeper slopes of the water table adjacent to the Kern River channel in the fall than the slopes generally apparent in the spring. The steady state water table presented on Plate 3 reflects a typical spring condition.

Under the steady state conditions, the water table is maintained by about 22,000 acre-feet per year of recharge from the river, return irrigation flows and spreading programs, about 34,000 acre-feet per year of groundwater inflow, and about 56,000 acre-feet per year of groundwater outflow.

Study Period

The period of simulation was 1953 to 1983 (31 years). The starting year is the year when Isabella Dam began to regulate the flows in Kern River.

NORTH-SOUTH GROUNDWATER TABLE PROFILE THROUGH PROJECT AREA [SPRING WATER LEVELS]



The study period contains both extremely wet years (1969, 1978, 1980) and extremely dry years (1961 and 1977). The selected period can thus be considered generally representative for future conditions.

Project Recharge

Water is available for recharge from both the Kern River and the State Water Project. A review was made to determine the approximate quantities of water that BMWD would have received if the proposed recharge project had been operational during the water years between 1953, when Lake Isabella became operational, and 1983. This 31-year historical record is adequate to demonstrate the operation of the recharge-extraction program.

Recharge water would have been available from the Kern River during years in which the Kern River - California Aqueduct Intertie was or could have been spilling water. This would have occurred five times during the 31 year study period. The actual or estimated days the Intertie was or would have been spilling water were described under Project Description, Sources of Water for Spreading. Recharge available from the Kern River when the Intertie would have operated was based on the capacity of the infiltration ponds, i.e. 0.2 feet per day per acre over the BMWD recharge area. It was assumed that surplus State water could not be recharged during years of Intertie spilling because the entire capacity of the ponds is used to recharge Intertie water. Table 11 shows the estimated amounts of recharge.

BMWD has contracted with the Kern County Water Agency to receive water from the State Water Project. Deliveries from the State Water Project are projected by the Department of Water Resources (DWR), Statewide Planning Branch. Their Study No. 1990-EDPP-03A was used to determine the availability of entitlement and surplus water. This study is based on hydrologic conditions from the years 1923 to 1978, a 1990 level of development, and the assumption that an East Branch groundwater storage facility will be the only new State Water Project or Central Valley Project facility in operation. No additional conservation facilities, including the Peripheral Canal, are assumed in the study.

TABLE 11

RECHARGED SURPLUSES AND PUMPED DEFICITS
 BMD SPREADING PROJECT
 1953-83 FLOWS, 1990 STATE OF DEVELOPMENT
 (acre-feet)

Year	(1) Table A Water Received	(2) Required Irrigation Water	(3) Surplus(-)/ Deficit(+) (2)-(3)	(4) Total SWP Surplus	(5) Surplus to Berranda Mesa 0.06 x (4)	(6) Intertie Spilling	(7) Recharged Surplus (-3)+(5)+(6)	(8) Pumped Deficits Case I	(9) Pumped Deficits Case II
1953	155,100	140,000	-15,100	13,000	780	-	15,880	-	-
54	155,100	140,000	-15,100	-	-	-	15,100	-	-
1955	155,100	140,000	-15,100	-	-	-	15,100	-	-
56	155,100	140,000	-15,100	-	-	-	15,100	-	-
57	155,100	140,000	-15,100	-	-	-	15,100	-	-
58	155,100	140,000	-15,100	-	-	-	15,100	-	-
59	155,100	140,000	-15,100	-	-	-	15,100	-	-
1960	116,250	140,000	23,750	-	-	-	-	20,000	23,750
61	116,250	140,000	23,750	-	-	-	-	20,000	23,750
62	116,250	140,000	23,750	-	-	-	-	20,000	23,750
63	155,100	140,000	-15,100	75,000	4,500	-	19,600	-	-
64	155,100	140,000	-15,100	-	-	-	15,100	-	-
1965	155,100	140,000	-15,100	-	-	-	15,100	-	-
66	155,100	140,000	-15,100	-	-	-	15,100	-	-
67	155,100	140,000	-15,100	-	-	-	15,100	-	-
68	155,100	140,000	-15,100	108,000	6,480	-	21,580	-	-
69	155,100	140,000	-15,100	51,000	3,060	22,040	34,675 1/	-	-
1970	155,100	140,000	-15,100	85,000	5,100	-	20,200	-	-
71	155,100	140,000	-15,100	-	-	-	15,100	-	-
72	155,100	140,000	-15,100	-	-	-	15,100	-	-
73	155,100	140,000	-15,100	-	-	-	15,100	-	-
74	155,100	140,000	-15,100	-	-	-	15,100	-	-
1975	155,100	140,000	-15,100	166,000	9,960	-	25,060	-	-
76	77,550	140,000	62,450	-	-	-	-	20,000	40,000
77	15,510	140,000	124,490	-	-	-	-	20,000	40,000
78	155,100	140,000	-15,100	-	-	7,980	23,080	-	-
79	155,100	140,000	-15,100	-	-	-	15,100	-	-
1980	155,100	140,000	-15,100	100,000 E	6,000	10,640	25,740 1/	-	-
81	155,100	140,000	-15,100	-	-	-	15,100	-	-
82	155,100	140,000	-15,100	205,000 E	12,300	1,425	16,525 1/	-	-
83	155,100	140,000	-15,100	205,000 E	12,300	5,605	20,705 1/	-	-

1/ Use of spreading area during flow through Intertie prevents full usage of State Water Project surplus water.

E - Estimated quantities.

BMWD has contracted with Kern County Water Agency to receive 163,200 acre-feet of Table 1 water. Of that amount, 155,100 acre-feet is Table A water. According to the DWR study, BMWD will receive their full allotment of Table A water in 26 of the 31 years. BMWD considers its actual annual demand to be 140,000 acre-feet on the average. Thus 15,100 acre-feet of Table A water are available for recharge in each year the full Table A allotment is provided. In Table 11 these surpluses and deficits are also presented in relation to the 140,000 acre-feet per year of actual demand.

Of the 163,200 acre-feet of Table 1 water from the Kern County Water Agency, 8,100 acre-feet is not Table A water and is subject to availability of surplus water from the State Water Project. The DWR study shows that under the 1990 level of development used, surplus water would have been available in six of the years between 1953 and 1978. During these six years, BMWD would have received some Table 1 water in excess of their Table A water. BMWD has priority for surplus water which is part of their Table 1 allotment, over surplus water for other uses such as overdraft correction. Table 11 shows the total surplus water available to the State Water Project, and the amount that BMWD is expected to receive.

BMWD's share of the surplus water was determined by reviewing DWR records. A recent study (DWR, 1981) indicates that Kern County Water Agency is projected to receive 74.3 percent of the surplus water delivered between 1981 and 1986, and 78.4 percent of the surplus water delivered between 1984 and 1986. Therefore, Kern County can be expected to receive approximately 75 percent of the total surplus water during the design period of the recharge projects. BMWD has contracted with the Kern County Water Agency to receive 8,100 acre-feet of the first 100,000 acre-feet of surplus water received by the Agency (Table 1 deliveries). Hence, BMWD will receive approximately eight percent of the surplus water delivered to the Agency, or six percent of the total available surplus water.

Pumping

Pumping is necessary in years when deliveries of Table A water fall short of the 140,000 acre-feet of annual demand by BMWD. The amount of pumping from the proposed project is presently limited to a total of 5,000 acre-feet per year from three existing wells.

Two cases were considered for the computer simulation of the ground-water basin. Case I is based on wells being located on project lands with a total capacity of 20,000 acre-feet per year, while in Case II 40,000 acre-feet per year would be pumped. For Case II, pumping capacity exceeds the needed deficit in 1960-62 but falls short in the dry 1976-77 period. For both cases a total of 433,000 acre-feet would be recharged over the 31-year period.

The drawdown of a single well, penetrating the entire unconfined aquifer (about 500 feet from ground level), was calculated by the Theis-Method and shown in the tabulation below. The discharge was assumed to be a constant 4,000 gpm over a period of one year. This is equivalent to about 6,400 acre-feet in a year. The transmissivity was set at 300,000 gpd/ft and the storage coefficient at 18 percent (based on average values for the study area from the Kern County groundwater model). A sensitivity analysis showed that a transmissivity of 200,000 gpd/ft increases drawdowns by about 20 percent while variations of the storage coefficient have a very small effect on the drawdown.

To obtain the drawdown of several identical wells, the drawdown listed in the following table has to be superimposed.

<u>Distance from Center of Well (feet)</u>	<u>Drawdown After One Year (feet)</u>
1	36
10	29
100	22
1,000	15
10,000 (2 miles)	8

Results of Simulation

The effects of this program on the aquifer were simulated for two cases of pumping over nine historical periods, with durations ranging from one to seven years during 1953-83 (Table 12). Water table contours under steady state conditions are shown on Plate 3. Water levels in 1975 following an extended period of simulated recharge are shown on Plate 4, and water levels after a period of pumping during 1976-77 drought are illustrated on Plates 5 and 6.

In Case I over the 31-year period, 100,000 acre-feet would be removed by pumping, 179,000 acre-feet would flow out of the study area into other areas of the basin, and inflows into the study area from other parts of the basin would be reduced by 57,000 acre-feet due to the recharge. At the end of the 31 years, about 96,000 acre-feet of the water recharged would still be in storage in the study area. The minimum in storage over the 31-year period would be -7,750 acre-feet at the end of 1962. The maximum in storage would be 113,700 at the end of 1975.

In Case II, about 151,000 acre-feet would be removed over the 31-year period by pumping. About 155,000 acre-feet would flow out of the study area and inflows would be reduced by 49,000 acre-feet due to the recharge. At the end of the 31-year period there would be about 77,000 acre-feet of water in storage in the study area. The minimum in storage over the 31-year period would be -17,640 acre-feet at the end of 1962. The maximum in storage would be 111,600 at the end of 1975. See Figure 8 for a graphical presentation.

Discussion

The simulation as reflected Figure 8 indicates that BMWD could have operated the proposed program for either Case I or Case II pumping under hydrologic conditions existing between 1953 and 1983 with an overall net benefit to groundwater users in the study area. During drought periods more water is withdrawn than recharged, but in no instance is the cumulative recharge, minus pumped water, less than zero. Thus there is no negative balance in the groundwater basin during the 31-year period. Future hydrologic conditions may be expected to differ from those in the past, but the selected study period is believed to be sufficiently long to assure representative conditions.

TABLE 12

WATER BALANCE OF RECHARGE AND PUMPING AT BAMD SPREADING PROJECT
(acre-feet)

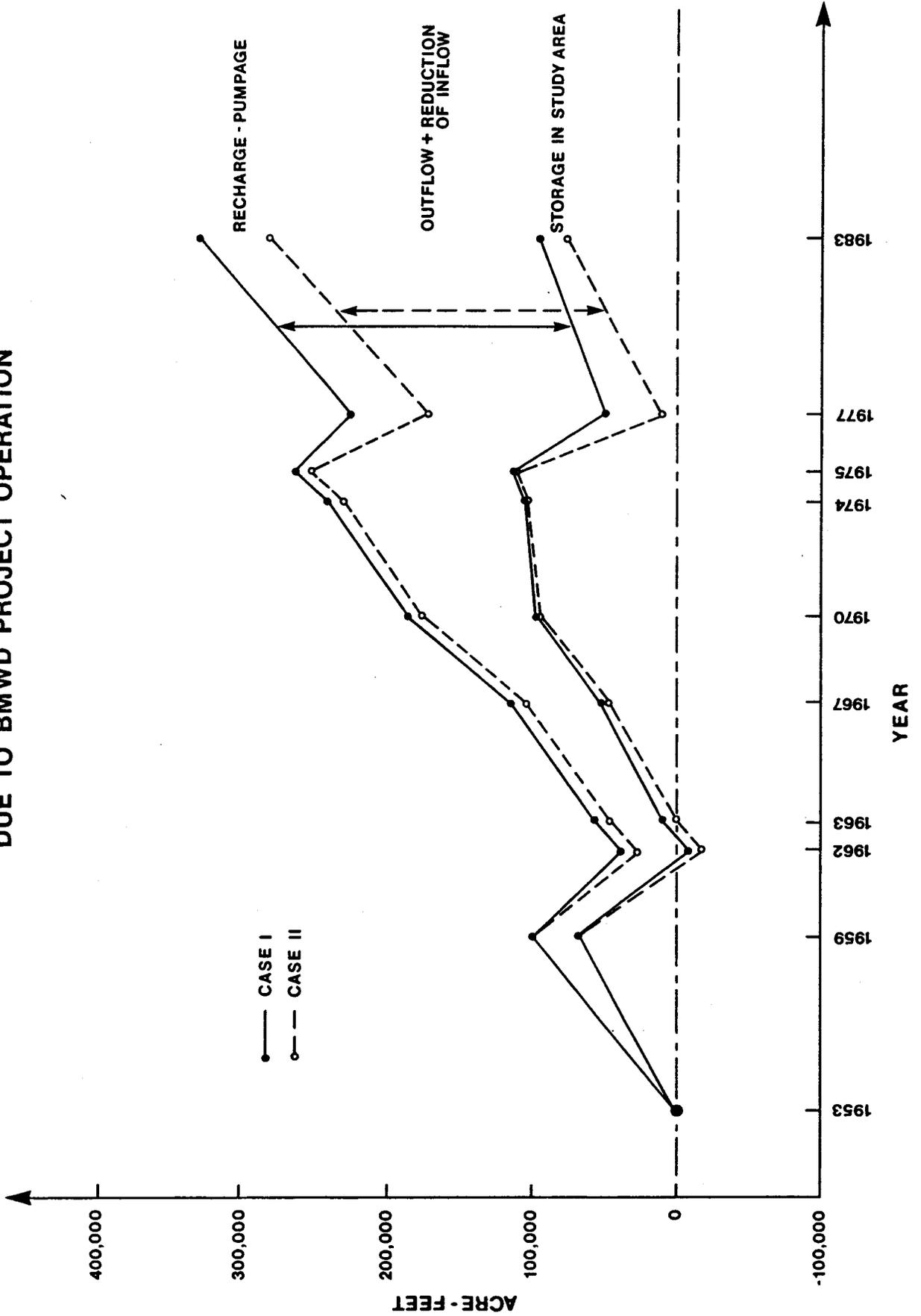
Simulation Period No. Years	Case I				Case II					
	Boundary 1/ Inflow	Boundary 1/ Outflow	Recharge	Pumping	Storage Change	Boundary 1/ Inflow	Boundary 1/ Outflow	Recharge	Pumping	Storage Change
1 1953-59	-9,213	+24,113	+99,176	-	+65,850	-9,213	+24,113	+99,176	-	+65,850
2 1960-62	-2,275	+11,324	-	+60,000	-73,599	-1,774	+10,468	-	+71,250	-83,492
3 1963	+165	+1,541	+18,258	-	+16,882	+477	+956	+18,258	-	+17,779
4 1964-67	-3,563	+10,160	+56,260	-	+42,537	-2,722	+7,552	+56,260	-	+45,986
5 1968-70	-7,052	+18,146	+70,917	-	+45,719	-6,689	+16,753	+70,917	-	+47,475
6 1971-74	-12,455	+37,422	+56,260	-	+6,383	-12,202	+36,259	+56,260	-	+7,799
7 1975	-3,229	+10,171	+23,344	-	+9,944	-3,181	+9,947	+23,344	-	+10,216
8 1976-77	-4,943	+18,662	-	+40,000	-63,605	-3,796	+16,569	-	+80,000	-100,365
9 1978-83	-14,315	+47,642	+108,288	-	+46,331	-9,423	+32,748	+108,288	-	+66,117
TOTAL	-56,880	+179,181	+432,503	+100,000	+96,442	-48,523	+155,365	+432,503	+151,250	+77,365
TOTAL ROUNDED	-57,000	+179,000	+433,000	+100,000	+96,000	-49,000	+155,000	+433,000	+151,000	+77,000

1/ Amounts refer to deviations from the amounts that flow through the boundaries at steady-state conditions.

2/ Recharge from Berrenda Mesa Project, adjusted for evaporation.

Figure 8

CUMULATIVE WATER VOLUMES IN STUDY AREA
DUE TO BMW D PROJECT OPERATION



Comparison of Plate 3, showing the groundwater levels without the project, and Plate 4, showing the water table in 1975 after 23 years of project operation, indicates that water levels in the immediate vicinity of the project would have risen about 30 feet, and in a surrounding 30-square mile area north and south of Kern River the levels would have risen about 20 feet. Comparison of steady state water levels without the project (Plate 3) with those in 1977 after a two-year extraction period (Plates 5 and 6), shows that the project would have resulted in an overall improvement in area wide water levels under both Case I and Case II pumping rates but a decrease of about 10 feet in water levels in an area of about five square miles in and around the project under Case II pumping rates.

Actual pumping and recharge sequences will not be as uniform as the modeling results; however, the overall effects are reasonably reflected by the model.

Effects on Natural Recharge

Natural recharge in the investigated area includes percolation from Kern River and underflow from adjacent aquifers. These sources maintain a groundwater ridge along Kern River. The height and steepness of this ridge fluctuates seasonally and with wet and dry years.

The BMWD recharge program will tend to divert the general groundwater flow towards areas north and south of the recharge basins, but this effect will be relatively insignificant. Recharge from Kern River may be affected in the area where the river passes between the recharge basins. The saturated zones created by the recharge areas will raise the water table around the river and thus decrease the gradient and groundwater flow away from the riverbed. However, as indicated in Table 11, most of the recharge water is from the State Water Project and can be spread at times when there is no natural river recharge. Thus this phenomenon would only occur when the Intertie spills, and at such times the combined recharge rate of both the river and the spreading basins is greater than the natural recharge rate.

Effects on Other Recharge Operations

Rosedale-Rio Bravo Water Storage District operates about 410 acres of recharge basins in areas north and west of the proposed BMWD project (Boyle Engineering Corp., 1980). The City of Bakersfield has a spreading project extending five miles along the Kern River beginning immediately downstream of the BMWD project. When fully developed the potential wetted area of the City's project will be 1,241 acres (Stetson Engineers, 1983).

The BMWD project is expected to result in some decrease in the rate of local natural recharge from the Kern River, but the project will result in a long-term increase in the amount of water in the groundwater basin. The groundwater model incorporates the effects of the Rosedale-Rio Bravo and existing City of Bakersfield spreading projects since their operation is reflected in the steady state conditions that were assumed for the model. The model does not incorporate the effects of the proposed increased spreading and extraction operations of the City since the amounts of water recharged and extracted cannot be quantified based on available data. However, the effects of the program on the City of Bakersfield recharge area is expected to be negligible because of the location of both recharge areas along a groundwater ridge underlying the Kern River channel. Both recharge areas will cause increased groundwater flow towards the north and the south and are not expected to significantly interfere with each other.

One of the recharge areas of Rosedale-Rio Bravo Water Storage District is a 172-acre spreading basin one-half mile north of the BMWD project. The groundwater gradient in this area is towards the northwest, and the recharge mounds created by the two areas could interfere with each other after prolonged periods of recharge. It is considered unlikely, however, that water levels will rise to a point where the infiltration capacity of either of the ponds could be noticeably decreased because of the low rate of recharge in the Berrenda Mesa spreading area. If mounding is observed to cause interference with the Rosedale-Rio Bravo project, BMWD could limit its spreading operation to a certain time period (or rate) that would mitigate the interference.

The quality of water from the State Water Project that will sometimes be used for recharge is generally superior to or equivalent to the groundwater quality and will not result in any reduction in infiltration rates over those presently achieved by recharging with Kern River water.

Effects on Groundwater Quality

Operation of the project is expected to have an overall positive impact on the quality of groundwater, since the quality of the various surface water sources that can be used for recharge is generally either superior to or equivalent to that of the groundwater. Water from the State Water Project is sometimes of poor quality, particularly during times of drought in northern California; however, such water will not be used for recharge because spreading operations are planned only when there is surplus water from the State Water Project.

Some degradation in the quality of the recharge water can be expected due to leaching as the water percolates through the soils and sediments overlying the aquifer. In general, this effect is considered to be minor in this area where the river flows have already leached much of the soluble material from the soils. However much of the proposed spreading area has been farmed in the past, thus some of the nutrients from fertilizers that have not already decomposed or been taken up by plants will be leached out by the recharge water. It is not known whether pesticides have been used on the farmed areas, but any organic compounds such as DBCP or aldicarb usually decompose within a few months of application. DBCP was decertified for use in California in 1977. Any adverse effects of leaching may be expected to decrease with time as the more soluble mineral constituents will be dissolved first, leaving fewer and fewer constituents which are susceptible to solution.

The proposed mosquito and pest abatement program in the spreading area involves the possible use of a variety of pesticides. In implementing this program, the types of pesticides used and the methods of application must be such that movement of contaminants out of the project area is prevented and any degradation of the groundwater quality is minimized.

The nearby housing development reportedly has septic tanks for sewage disposal at the present time, with provision of dry sewer lines for eventual connection. The generally higher groundwater levels resulting from the project could possibly interfere with septic tank discharges if mitigation measures are not provided.

Reduction of Non-Renewable Resources

Construction and maintenance of levees will require use of vehicles and equipment which use non-renewable fossil fuels. Operation of the project will result in a long-term net increase in groundwater levels thus effecting an overall decrease in the amount of energy required for pumping.

Health Hazard

When project lands are being used for spreading, the standing water could provide a habitat for mosquitoes. One species of mosquito, Culex tarsalis, is a carrier of encephalitis. Shallow, warm standing water may also provide the opportunity for botulism outbreaks which can affect wildfowl populations. The proximity of a residential area just east of the project increases the potential health hazard.

Air Quality

There will be a temporary introduction of air pollutants and dust caused by mechanized equipment during construction of the required levees. The occasional rehabilitation of the spreading basins will also result in similar localized air pollution. The amount of pollution will be small and will have no significant effect on the environment.

Mineral Resources

The existing oil and gas well production facilities on project lands will be subject to inundation if mitigation measures are not provided. Deed restrictions require continued access to such facilities.

Archaeological Resources

A site records search and literature review indicate that there are no known archaeological sites on project lands. (See Appendix A).

Effects on Nearby Canals

There is a potential for failure of a concrete lined canal due to the uplift forces of a high groundwater table. In light of a nearby recent failure in the lining of the Cross Valley Canal, the potential for a future failure would likely increase in the reach of the canal that traverses project lands unless mitigation measures are provided. The canal lining will be stable as long as the uplift forces, caused by the increase in groundwater levels during spreading, do not exceed the weight of the concrete lining plus the weight of water in the canal.

Urban Growth

The project will result in general improvement of groundwater conditions which may enhance agricultural use of water. Conceivably, this could indirectly influence urban growth through expanded services to the agricultural community.

UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Most of the adverse environmental impacts discussed in the preceding section are considered to be either insignificant or the impact can be mitigated to a great extent. Those adverse impacts that may be considered significant are the potential loss of riparian habitat, lowering of groundwater levels during pumping, the increased mosquito breeding, the potential for soil liquefaction and damage to houses during earthquakes, and the possibility of damage to the Cross Valley Canal lining due to high groundwater. The mitigation of these and other impacts is discussed in the following section.

Unavoidable adverse environmental impacts are the repeated disturbance of the habitat by both mechanical and chemical methods, and the induced growth of water extraction activities in a concentrated area.

MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS

Adverse Impacts During Construction

The noise and dust caused by operation of heavy equipment during construction will impact only the area in the vicinity of the housing development off Stockdale Highway. To the extent possible, equipment with low noise levels will be used, and construction will be done only during normal daylight working hours. Dust can be controlled by watering if it is found to be excessive. The duration of construction is expected to be about 10 days.

Lowered Groundwater During Pumping

The adverse effects of lowered groundwater levels due to pumping will be limited by not extracting more than 40,000 acre-feet in any single year and by always maintaining a positive balance (recharge less pumpage) of water in the groundwater basin.

Alteration of Habitat

Several measures are planned which will moderate or mitigate the habitat alteration resulting from the project. Riparian habitat zones will be established along both banks of the Kern River to allow a fringe of trees and shrubs which will provide habitat for wildlife species that depend on the river bank for cover, food and nesting sites. Additionally, a portion (as yet undetermined) of the 75-acre parcel north of the river will be allowed to revert to native riparian and marshland habitat. Hunting will be prohibited for safety reasons and for wildlife protection, as well as to augment the planned wildlife preserve status of the downstream City of Bakersfield spreading area. Grazing by livestock and use of off-road recreational vehicles will be prohibited in the area. Monitoring and maintenance programs will be established to mitigate continued habitat alteration by the project. A detailed, phased maintenance program will be developed for vegetation and rodent control, mosquito abatement and desiltation such that breeding periods of wildlife are minimally disrupted.

Reduced Access to Mineral Resources

The existing access roads leading to oil and gas wells will be raised above the water level and dikes will be constructed around the well sites.

Increased Soil Liquefaction Potential

Because the engineering properties of the soils underlying and adjacent to the project are not known, the potential for liquefaction of saturated soils cannot be assessed. Until soil tests are performed, it must be assumed that saturated soils in the area would liquefy in the event of a strong earthquake and that there is a potential for damage to houses in a new development being constructed on lands northeast of the project. To protect these houses from shallow saturated soil conditions, the spreading ponds in the NW 1/4 Sec. 2 will be set back from the western edge of the development to avoid any dangerously high phreatic surface, pending the results of soil investigations which will be performed prior to initiating spreading operations. The soil investigation will also determine whether there may be a shallow clay layer that could shunt recharge away from the project.

Hazard of Induced Uplift of Canal Linings

The potential hazard to the Cross Valley Canal lies in the possibility of failure of the concrete lining due to the uplift forces of a shallow groundwater table. If it is assumed that the phreatic surface from spreading basins adjacent to the canal slopes at one foot of drop for every fifteen feet of horizontal distance away from the edge of the basin, this phreatic surface would intersect the canal lining at an elevation below the operating water surface of the canal if a 12-foot wide levee were constructed adjacent to the toe of the canal levee. Under such conditions the canal lining would not be endangered and the canal embankment will not be used for enclosure. Piezometers installed in the canal embankment could be used to monitor the phreatic surface.

Increased Health Hazard

A program for mosquito abatement will be established to control their incidence by dewatering, spraying or by minimizing shallow areas which lend themselves to mosquito breeding. The spreading basins will be monitored period-

ically to assure the effectiveness of the mosquito abatement program. The establishment of tules, cattails, and other water loving plants within the basins will be prevented, since areas with such plants offer ideal conditions for mosquito breeding. The methods, frequency and extent of controls will be determined in accordance with guidelines established by the Kern County Mosquito Abatement District and appropriate state agencies to assure that the program will be effective and that no groundwater contamination results from the application of chemicals.

Ponds will be constructed so as to provide water depth of at least 12 to 18 inches and a minimum of shoreline. Gradually reduced shallow water depths along pond edges will be avoided in favor of steep banks. In addition, gated culverts will be provided to permit flow from pond to pond and allow rapid draining when necessary.

Potential botulism hazards in groundwater recharge areas can be minimized by careful construction of the ponds and proper operational and maintenance procedures. Ponds will be operated so as to maintain water levels at nearly constant levels. Capacity of the recharge system will be changed by deleting or adding a pond to the system rather than by adjusting water levels throughout the recharge system. The reason for maintaining as constant water levels as possible is to avoid killing animals whose bodies become sources of toxin to waterfowl. The gated culverts will be carefully regulated so as to avoid stagnating water.

Disturbance of Archaeological Sites

A site records search and literature review indicated no recorded archaeological sites within the project area (Appendix A). However, it is planned to conduct an archaeological survey of project lands lying north of the Cross Valley Canal, which have not previously been developed for spreading, prior to their development as percolation ponds.

In the event that any artifacts or other cultural remains are found during construction or operation of the project, the area in which the remains were found will be left undisturbed until an archaeological site investigation is conducted.

Hazard to Water Quality

During times of drought in northern California, water from the State Water Project may be of poor quality. At such times no water will be recharged, since the BMWD project will depend on the availability of surplus water.

The mosquito abatement program may require the application of certain chemicals, either as pesticides or herbicides. The pesticides variously act as larvicides, growth regulators, or as chemicals to control adult populations. Certain of these chemicals are safe to use on ponded waters and others are biodegradable. The selection of chemicals to be used in the mosquito abatement program will be closely coordinated with the local mosquito abatement district and appropriate state agencies to assure that no degradation of groundwater quality will occur as a result of the program.

ALTERNATIVES TO PROPOSED PROJECT

No Action

If the project were not implemented, the land would not be used for groundwater recharge and the attendant water conservation measures would not accrue. The contribution of the project to alleviating groundwater quality problems and increasing pumping costs in the basin would not be made. No economic benefits would ensue to the surrounding agricultural community as a result of the favorable long-term impact on the groundwater basin.

Under the no action alternative, the land south of Kern River could revert to its former agricultural use, while project land north of the river could be developed either for agricultural use or as an urban area such as the adjacent housing development presently being constructed.

The riparian area adjacent to the Kern River that is envisioned as part of the proposed project would not be designated and there would be no concomitant enhancement of the natural riparian habitat.

Use of Existing Spreading Area

There are presently 240 acres of project land south of the river that have been developed and operated for spreading by Kern County Water Agency under a one-year agreement with BMWD. An alternative to the proposed project would be to extend this agreement and allow the Agency to operate the spreading program in this area, or BMWD could itself operate the program. This would not allow development of the full spreading potential of the area and would result in less conservation of water.

Alternative Methods of Recharge

The groundwater basin could be recharged by means of injection wells, thus allowing multiple uses of project lands. However, injection requires the use of treated water and is an inefficient use of sizeable amounts of energy and other resources for treatment and pumping.

BMWD could negotiate an agreement with the City of Bakersfield or with Rosedale-Rio Bravo Water Storage District to recharge BMWD water in their spreading facilities. Such an agreement, if it could be obtained, would result in no net increase in the capacity of spreading facilities along the Kern River. There could be an increase in cost to BMWD due to the spreading charges from either the City or Rosedale-Rio Bravo WSD.

Alternative Sources of Water

BMWD has pursued various alternatives in an effort to obtain a water supply for the District in dry years. In 1976 BMWD investigated the feasibility of installing a well field on District lands but was able to pump only a small quantity of brackish water from a prototype well. During the drought of 1977 BMWD negotiated for the purchase of groundwater from landowners in Sacramento, Sutter and Yuba Counties but was unable to arrange for transport of the water to District lands. Also in 1977 the District investigated the purchase of lands and constructing a well field in the Green Valley Water District, northeast of BMWD, but this was determined to be economically unfeasible.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S
ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT
OF LONG-TERM PRODUCTIVITY

The proposed project is envisioned as a long-term commitment to the conservation of the Kern County water supply, and it will assure BMWD and others a source of emergency water supply during times of drought. There will be an overall net increase in groundwater levels, resulting in lower energy costs. The project will also enhance groundwater quality.

On lands permanently taken for spreading, the project will result in a loss of land for agriculture but an augmentation of wildlife habitat along the Kern River.

IRREVERSIBLE ENVIRONMENTAL CHANGES

The facilities required for the proposed project will consist primarily of low earth levees and water wells, thus there is no large commitment of land that is irreversible. The water used in the project is a renewable resource. However construction and implementation of the BMWD project will require an irreversible commitment of energy, labor, and money.

Energy

Energy will be required to operate the several pumping plants included with the State Water Project and Cross Valley Project to import water to the area for spreading. Energy will also be required to pump the groundwater for use.

Labor

Many man-hours of labor will be required to design, construct, and operate the project. The decision to go ahead with the project represents an irreversible commitment of this resource.

Money

By the same token, the decision to proceed with the project will require an irreversible commitment of money to initially finance elements of the project, and additional sums to operate and maintain the facilities.

GROWTH-INDUCING IMPACTS

BMWD agricultural land is fully developed and there are no plans for future development of new lands. The water that is recharged by the project and used by BMWD constitutes an emergency supply available in times of drought to sustain permanent crops such as almonds, pistachios and grapes.

ORGANIZATIONS AND PERSONS CONSULTED

This report was prepared for Berrenda Mesa Water District by the staff of Leedshill-Herkenhoff, Inc., under the general guidance of James S. Jenks, Principal Engineer, and Philip L. Wagner, Principal Engineering Geologist. The ecological assessment of the project was prepared by Dr. George E. Lawrence.

Berrenda Mesa Water District furnished a preliminary copy of this report to the following organizations or their representatives for review and consultation in preparation of the Draft Environmental Impact Report.

California Office of Planning and Research, State
Clearing House
California Water Resources Control Board
California Department of Water Resources
California Reclamation Board
California Department of Fish & Game
California Department of Conservation, Division
of Mines and Geology
State of California, Central Valley Regional Water
Quality Control Board
Kern County Council of Governments
Kern County Health Department
Kern County Planning Department
Kern County Water Agency
City of Bakersfield, Planning Department
Kern Delta Water District
Rosedale-Rio Bravo Water Storage District
North Kern Water Storage District
Buena Vista Water Storage District

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