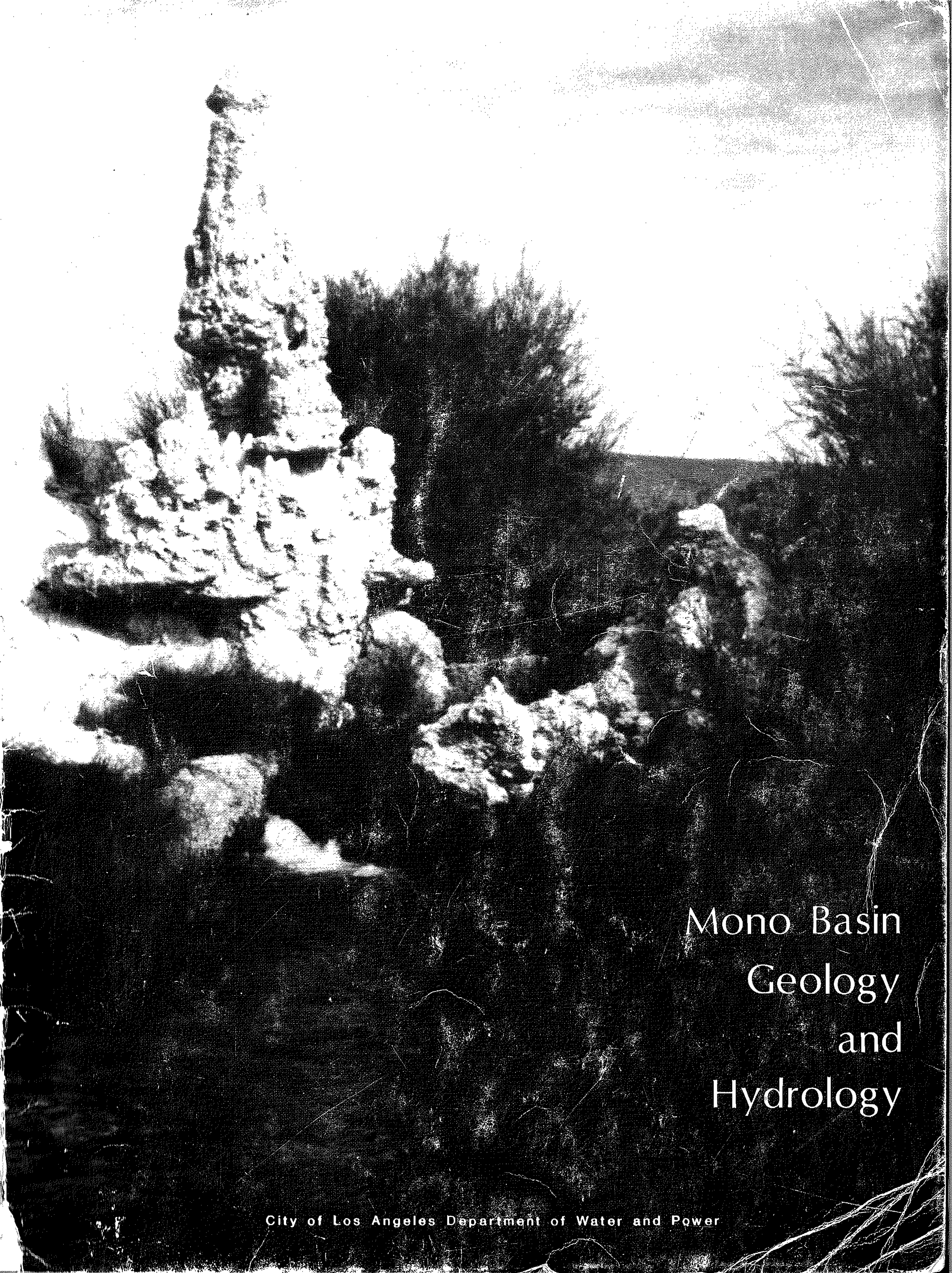

Mono Basin Geology and Hydrology

City of Los Angeles Department of Water and Power

LOS ANGELES DEPARTMENT OF WATER AND POWER
AQUEDUCT DIVISION - HYDROLOGY SECTION

MONO BASIN GEOLOGY AND HYDROLOGY

March 1987

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LOS ANGELES DEPARTMENT OF WATER AND POWER

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March 1987

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MONO BASIN GEOLOGY AND HYDROLOGY

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I. INTRODUCTION

Since 1940, the City of Los Angeles has been diverting a large portion of the streamflow tributary to Mono Lake. The lake itself is naturally saline -- even in 1883 it was much saltier than ocean water. The high salinity is related to a high evaporation rate in this arid climate, and an accumulation of salts carried in by the tributary streams, especially during the last several tens of thousands of years, during which time there has been no spill from this closed basin. The diverted waters are collected and allowed to flow by gravity through the Mono Craters Tunnel and into aqueducts which bring the water to the City. The waters which come from the Mono Basin comprise about one-sixth of the City's total water supply.

As a result of the diversions, the level of Mono Lake has shown a decline, which has become a source of environmental concern. In May 1979, the Audubon Society filed a law suit against Los Angeles, seeking to reduce the City's export from the Mono Basin. In February 1983, the California Supreme Court ruled that the benefits associated with the continued diversion of water from the Mono Basin must be balanced against whatever adverse effects are determined to occur to the Mono Basin environment.

In an effort to understand these environmental effects, the Department of Water and Power of the City of Los Angeles (LADWP) has been engaged in intensive research on the many areas of concern -- biological, geological, hydrological, and air quality.

The particular areas of study were outlined in the July 18, 1983 report of the Committee on Interior and Insular Affairs of the United States House of Representatives in conjunction with bill H. R. 1341 which set up a Mono Basin National Forest Scenic Area. This report requires the Secretary of Agriculture to enter into an agreement with the National Academy of Sciences to study the ecology of the Scenic Area. It also requires consultation with knowledgeable persons, agencies, and organizations. LADWP is cooperating fully in this effort. The present report is directed primarily toward supplying information which will assist the National Academy of Sciences in arriving at findings and recommendations in item 3 of the Committee Report, which concerns:

> "The hydrology of Mono Lake, including ground water inflow, evaporation and fresh water spring inflow, and a water balance at the critical water level, showing the estimated evaporation and projected inflows;"

II. GENERAL DESCRIPTION OF THE MONO BASIN

Geographic Location

Mono Basin, in east-central California adjacent to the Nevada boundary, is a closed drainage area of about 750 square miles; approximately 365 sq. mi. are hill and mountain areas, and the remaining 385 sq. mi. consist of valley fill areas and the surface of Mono Lake. It lies at the eastern base of the Sierra Nevada and forms one of the many closed hydrologic basins within the Great Basin region. Mono Basin is located mostly in the County of Mono, nearly 190 miles due east of San Francisco and over 300 miles north of Los Angeles, and shares its western watershed boundary with Yosemite National Park (Figure 1).

Physical Features

Mono Basin is surrounded by mountains which slope steeply toward Mono Lake, the lowest part of the basin. Elevations of the ground surface range from over 13,000 feet along the peaks of the Sierra Nevada to about 6,400 feet at the shoreline of Mono Lake. Mono Lake occupies the central portion of the basin and has a present surface area of about 69 square miles (March 1987). The lake is generally elliptical in shape with a long axis of nearly 13 miles and a short axis of about 9 miles. (Figure 2).

Mono Basin once contained a much larger and deeper lake than at present. Evidence of Pleistocene (Ice Age) Lake Russell which covered more than 315 square miles (202,000 acres) is revealed by elevated beach lines hundreds of feet above the present lake level, and by lacustrine deposits which filled Mono Basin to depths of several thousand feet. At its maximum extent, over five times its present size, Lake Russell extended northeasterly into Aurora Valley (in Nevada) and overflowed southeasterly to Adobe Valley.

Mono Lake derives the principal portion of its water supply from the streams and creeks that flow from the eastern slope of the Sierra Nevada. The lake constitutes the ultimate sink for all undiverted surface flow or groundwater underflow within the basin. Numerous perennial springs near the shore and underneath the lake surface contribute considerable inflow to the lake. The springs throughout the basin are sustained by percolation of rainfall and stream flows in the hill and mountain areas or in higher portions of the valley fill.

Since Lake Russell stopped spilling, near the end of the Pleistocene, it has had no outlet. As the large lake's volume was decreased by evaporation, and as additional salts were contributed by inflowing surface and ground waters, the salinity of the lake's water increased. As of July 1986, Mono Lake was about two and one-half times greater in salinity, at an average of 80.4 parts per thousand (ppt) total dissolved solids (TDS), than the Pacific Ocean at 34.4 ppt TDS, but contained only about one-third the TDS of the Great Salt Lake in Utah at about 272.0 ppt TDS.

As of October 1, 1986, Mono Lake covered approximately 69 square miles (44,000 acres) and its surface was at elevation 6380.20 feet. The deepest part of Mono Lake is near the southern border of the terrace surrounding Paoha Island in what has been named the Johnson Basin, after W. D. Johnson the topographer who worked with I. C. Russell (Russell, 1889); at present lake levels, the greatest depth is about 150 feet. The average depth is currently (1987) calculated to be 56 feet (2,461,800 acre-feet Volume divided by 44,000 acres Surface Area).

Located near the center of Mono Lake are two prominent volcanic islands (Figure 2). Paoha, a Piute Indian word for "Spirits of the nest", referring to hot springs vapors at the eastern end of the island, is about three square miles in area with a maximum elevation over 310 feet above the current lake surface. The second island, about a half square mile in area, is called Negit, the Piute name for the California gulls which nest in the Mono Lake area in the summer.

In addition to numerous natural fresh water lakes in the watershed west of Mono Lake, there are several small reservoirs located in the Sierra Nevada in the upper reaches of Rush, Lee Vining, Parker, Walker, and Mill Creeks, the major streams of the Mono Basin. These reservoirs are operated for hydroelectric power production and water supply control purposes.

The only town in the basin that has survived since the gold mining boom of the 1850's is Lee Vining, at the foot of the Tioga Pass Road to Yosemite. Lee Vining was founded in the 1850's to serve farmers and miners. Currently, the town has a population of about 500, and provides service to the tourists traveling Highway 395.

Climate

Most storms affecting the Mono Basin watershed originate in the Gulf of Alaska. The moisture-laden winds from the Pacific Ocean deposit most of their moisture on the western Sierra slopes. Orographic influence is quite evident as precipitation diminishes rapidly with decreasing elevation on the steep eastern escarpment. Annual precipitation averages over 30 inches near the topographic divide of the Sierra Nevada, declines to 15 inches or less at the base of mountains, and to less than 6 inches on the east side of Mono Lake. The average depth of snowpack in the Sierra Nevada has been about 76 inches per year but can vary substantially from year to year. Over the 54-year period 1924-1978, the snowpack at Gem Lake Precipitation Station, has ranged from a high of 178 percent of normal to a low of 44 percent of normal.

The arctic-like winters in the high mountains are in sharp contrast to the drier and warmer conditions at the lower elevations of Mono Basin. The valley floor, existing in the rain shadow of the Sierra Nevada, receives an average of less than 10 inches of precipitation per year, and has a desert climate typical of high elevation.

Mono Basin has distinct seasons. Snowfields form during the cold winters and melt as the weather warms up in the spring. The seasonal distribution of precipitation in Mono Basin is typical of California; more than 80 percent of the annual amount occurs in the six months October to March. Nearly 75 percent of the stream flow from snowmelt occurs in the six-month period from April through September. Minor amounts of summer precipitation occur as thunderstorms, originating in the Gulf of Mexico or in the southwest Pacific Ocean.

Temperatures vary considerably seasonally and with elevation within the basin. Daily variations of more than 40°F are not uncommon at any given spot on the valley floor due to the shielding effect of the mountain ranges flanking the valley. Hot summer afternoons are approximately 30 degrees warmer in the valley than in the glacier-topped Sierra Nevada.

Meteorological records collected by Los Angeles DWP at Cain Ranch, located west of Highway 395 near Parker Creek at elevation 6,850 feet, provide the following data:

METEOROLOGICAL DATA

Type of Data & Period	Mean Annual	Maximum	Minimum
Temperature (1931-1979)	43°F	94°F	-18°F
Wind Speed (1961-1979)	5.5 mph	60 mph	2.8 mph
Precipitation (1931-1979)	11.1 In/Yr	22 In/Yr	5.5 In/Yr

Temperatures recorded at Mono Lake are consistently 5°F warmer than those at Cain Ranch. When temperatures are below freezing, the difference can be even greater. Altitude would account for only about 1°F of the difference between the two locations. Mono Lake appears to provide a localized, water-related warming effect for the basin.

Land Use and Water Rights

Development in the Mono Basin started in the 1850's and was related to gold mining and lumber mills. There was some farming to supply food for the mining towns. Following the stock market crash of 1881 and the termination of most mining activity, only about 100 families remained in the basin. Those families farmed about 50,000 acres of land for the next 30 years.

Considerable dispute ensued during the period 1915 to 1920 over whether the easements granted under the Federal Act of 1891 were mainly for power or irrigation purposes. The adjudication of Lee Vining and Rush Creeks left the Cain Irrigation Company and Southern Sierras Power Company, whose operations dated back to 1905, in control of most of the water and power rights.

As early as 1923, the City applied for the right to appropriate surface flow within the Mono Basin from Mill, Lee Vining, Walker, Parker, and Rush Creeks. In 1930, the voters of Los Angeles approved a $38 million bond issue to finance the Mono Basin Extension-Long Valley Reservoir Project. An extensive program of land and water rights acquisition was initiated. The City negotiated for the purchase of much of the private land in the basin and secured most of the riparian rights (Figure 2). The largest purchases of land were made from the Southern Sierras Power Company and the Cain Irrigation Company. All public lands in the Mono Basin were withdrawn from entry in the early 1930's by the Federal Government to protect the City's water rights.

The City reapplied for the right to appropriate in 1934, due to a planned change in the quantity of water to be diverted and the timing for storage, with the understanding that the 1923 priority date would not be lost. Permits were subsequently granted in 1940 by the State for the direct diversion of 200 cubic feet per second (cfs) and 93,540 acre-feet per year for storage. Through a separate water rights litigation in 1934, known as the Aitken Case, littoral rights on Mono Lake were acquired and compensation was paid to shoreline property holders. Construction on the Mono Basin Project began in 1934 and was finished in 1941 following the completion of the eleven-mile Mono Craters Tunnel and the dedication of the Crowley Lake Reservoir (Figure 4).

The control of Mono Basin diversions and Grant Lake storage levels is coordinated with Southern California Edison's hydroelectric generation and water storage facilities on Rush and Lee Vining Creeks. Surplus water in Grant Lake is released from the conduit between Grant Lake and the Mono Craters Tunnel; this is used for irrigation and spreading activities, or is allowed to flow to Mono Lake. Discharges to Mono Lake also occur from Lee Vining Creek during times of unusually high runoff.

In 1963, the City announced plans to build a Second Los Angeles Aqueduct, with a mean annual capacity of 210 cfs of export from Haiwee Reservoir. A portion of this supply, approximately 70 cfs, was planned to come from the surface waters in Mono Basin.

The Second Aqueduct was completed and placed into service on June 26, 1970. Since the beginning of this operation, the average export via Grant Lake Reservoir (flow to West Portal) has increased from 79 cfs (1940-41 through 1969-70) to 121 cfs (1970-71 through 1985-86). Based on the historical operation of the Mono Basin Extension, the State Water Resources Control Board (SWRCB), in 1974, issued a license to LADWP for a maximum diversion of 167,800 acre-feet per year for direct use and storage. Long-term plans of the LADWP call for an export of about 138 cfs (100,000 acre-feet per year). Under such a plan, releases from Grant Lake Reservoir and Lee Vining Creek would be reduced from 64 cfs (in the 1940-41 through 1969-70 period) to about 12 cfs mean annual flow. At the present time, however, (March 1987) there is a preliminary injunction requiring the release of 19 cfs into lower Rush Creek and a temporary restraining order which requires a release of 10 cfs down Lee Vining Creek.

On lands owned by the City of Los Angeles in the Mono Basin, about 13,000 acres are leased for dry grazing and 2,000 acres are leased for irrigated pasture. The water diverted for local uses on Mono Basin lands averages about 12 cfs, or 8,700 acre-feet per year.

III. GEOLOGY OF THE MONO BASIN

Introduction

The geology of the Mono Basin has been a subject of considerable interest since the visit of William H. Brewer in July 1863, as recorded in his posthumously published journal (Brewer, 1930). His visit was actually a part of the first Geological Survey of California (Whitney, 1865). Brewer observed the Mono Craters and noted that Mono Lake was saline and had no outlet. He mentioned that no fish or reptile lived in the lake, but that there were swarms of "worms" which grew into flies. The "worms" were a staple in the diet of the Indians.

In the 1870's an early visitor was Joseph LeConte, the first Professor of Geology at the University of California at Berkeley, who made observations on glaciers and extinct volcanoes. Early descriptions of the tufa tower springs were given in the Report of the U. S. Geological Exploration of the Fortieth Parallel in 1878.

The first comprehensive report on the geology of the Mono Basin was that of Israel C. Russell (1889). In the 1880's the central research interests of the U. S. Geological Survey in the Great Basin were the huge Pleistocene lakes which had shrunk since the end of the Ice Age -- Lake Lahontan and Lake Bonneville. Although Russell's main focus was Lake Lahontan, his interest in the Mono Basin was stimulated by his first visit in the spring of 1881. He returned late in 1882 but had to discontinue field work because of the severe winter storms. Field studies were resumed in the summer of 1883 with W.D. Johnson as topographer and W J McGee and George M. Wright as geologic aides. Russell's supervisor, G. K. Gilbert, of Lake Bonneville fame, made a short trip to the Mono Basin in the summer of 1883. Russell's contributions in the 1889 report have been reviewed by Steller (1984). Johnson's work resulted in the first good topographic map of the Mono Basin and the first bathymetric survey of Mono Lake. To preserve the lake level of November 5, 1883, Johnson chiseled a bench mark on a rock crag along the southwest shore of Negit Island. As will be discussed later, this bench mark has proven of great value in resolving conflicting evidence of lake levels over the last 130 years. Russell's observations have withstood the test of time in a remarkable manner. From his experience in the Lake Lahontan area, he had a good understanding of the Pleistocene shorelines, and of the relationships of multiple glaciations to the former stands of the lake, for which, in his honor, Putnam (1949) proposed the name Lake Russell. Not only did he recognize the geologic youthfulness of the Mono Craters but was aware that they had erupted during as well as after the last high stand of the lake. As evidence of post-glacial faulting, he cited the displaced morainal embankments at the mouth of Lundy Canyon, the fissures near the top of Black Point, and the scarps and folds in the lake beds on Paoha Island. He believed the Pleistocene lake had not overflowed, but later studies have proven otherwise (Lajoie, 1968).

From the time of Russell's report in 1889 to Blackwelder's classic paper on glaciation in 1931, there is almost nothing in the geologic literature on the Mono Basin. The decision to construct the Mono Craters Tunnel in the early 1930's stimulated interest in the geology of this area, leading to papers on the Mono Craters by Mayo and others (1936) and by Putnam (1938). Gilbert completed his Ph.D. dissertation on the area southeast of Mono Lake (1938a) and his famous paper on the Bishop Tuff (1938b). At about the same time, active investigators in this area were Kesseli (1939, 1941, 1948), Putnam (1938, 1949, 1950), and Dunn (1950). Gresswell (1940) gave a brief description of the geologic formations encountered in the driving of the Mono Craters Tunnel. During the 1950's and later, the early glacial studies of Matthes (1930) and Blackwelder (1931) were continued by Sharp and Birman (1963), Birman (1964), and Sharp (1969). Geophysical studies (gravity and seismic) have been conducted by Pakiser and others (1960, 1968, 1976) who felt that the Mono Basin was formed by subsidence along faults followed by extrusion of magma from a deep chamber. Pakiser's original suggestion of a great depth of basin fill (18,000 +/- 5000 feet) was vigorously argued. Pakiser's later suggestion was less than half of the original.

Using samples of pumice from the Mono Craters, Evernden and others (1959) were the first to show that radioactive techniques using potassium/argon (K/Ar) could be used to age-date late Pleistocene materials. Their work generated a great interest in age-dating using K/Ar and other methods; Dalrymple (1968) did additional K/Ar work on the Inyo Craters and the Mono Craters. Tadeucci and others (1968), using the same samples as Dalrymple, were able to apply Thorium 230 methods. Friedman and others (1968, 1976, 1981) used the hydration-rind method on obsidians from the Mono Craters and obtained results close to those obtained by K/Ar methods. For identifying sources of obsidian and vitric tephra, trace element analysis was used by Jack and Carmichael (1969) and strontium:rubidium (Sr:Rb) ratios by X-ray fluorescence (Parks and Tieh, 1966). Of great importance geologically, even on a world-wide basis, was the age-dating by K/Ar of the Bishop Tuff (700,000 years). This tuff overlies glacial till of Sherwin age -- one of the rare places in the western hemisphere where an older Pleistocene till is associated with an age-dated volcanic rock.

Outstanding contributions to the geology of the Mono Basin were the dissertations of Lajoie (1968) and Lee (1968). In the 1970's there was great interest in geothermal development and a surge in geologic endeavors. Two geothermal wells were drilled in the Mono Basin -- one near Panum Crater and one east of Black Point (Axtell, 1972). The 1980's have seen an even greater level of geologic interest because of the May 1980 earthquakes in the Mammoth Lakes area.

Geologic Structure

The Mono Basin is in the extreme western part of the Basin and Range physiographic province, just east of the uplifted fault block of the Sierra Nevada. The distribution of rock outcrops and fault lines is shown on the geologic map compiled by Chesterman (Plate 2). Note that all of the faults in the valley portion of the Mono Basin are dashed -- meaning they are believed to occur at depth at the indicated position, but are not exposed at the ground surface. Such faults stopped moving in the geologic past and have not moved in the Holocene. The recently completed bathymetric survey (Pelagos, 1986) suggests that there are many other faults expressed as linearities on the bottom of the lake, especially in the north-northwesterly direction (Plate 3).

There are few deep wells in the Mono Basin and little is known about the deeper geology. A well drilled on Paoha Island in 1908 to a depth of 1998 feet encountered shale or laminated silt to a depth of 1000 feet. The Bishop Tuff may have been encountered between depths of 1350 and 1625 feet. Hard basement rock was not reached. Two geothermal wells were drilled in the fall of 1971. One was drilled on the south shore near Panum Crater. It was whipstocked underneath the lake and reached a total vertical depth of 4056 feet; granite gneiss basement was found at a depth of 3820 feet. The other geothermal well was drilled on the north shore just east of Black Point. Weathered granodiorite basement was reached at 1740 feet. The log suggests that lake deposits and tufa extend to a depth of almost 900 feet, about the same as in the deep well on Paoha Island.

Several "models" have been suggested to depict the subsurface geologic structure of the Mono Basin. Based on seismic velocities, Pakiser and others (1960, 1968, 1976) have suggested a vertically downfaulted basin in which the downward movement is related to the outflow of liquid rock by volcanic eruptions. Lajoie (1968) doubted this explanation, and pointed out the difficulty of explaining what happened to the 200 cubic miles of volcanic material that was supposed to have come from beneath the basin. Gilbert and others (1968) pictured a sagging basin with only one major fault forming the boundary between the basin and the rising Sierran block. With either model, the structural evolution of the Mono Basin seems to be tied closely with that of Long Valley to the south. The basic geographic and geologic relationships as developed by Bailey (1982) are shown on Figure 7 and his schematic geologic cross-section is shown on Figure 8. For types of igneous rocks, see Figure 6.

Pre-Quaternary History

In the Mono Basin area, the geologic record before the Jurassic Period is very obscure (for Geologic Time Scale see Table 1). There are some rocks in the Sierra Nevada that may go back to the Early Paleozoic era, perhaps as early as the Ordovician or Silurian Periods. In the massive mountain block just west of Lee Vining are outcrops of the oldest sedimentary rocks, which were so changed by metamorphism (heat and pressure) as to have lost all of their original features. Other, somewhat younger metamorphosed sedimentary rocks (metasediments) date from the Pennsylvanian and Permian Periods. Still other metasediments and metamorphosed volcanic rocks (metavolcanics) are of Permian and Triassic age. All of these earlier rocks form roof pendants in the batholithic mass of the Sierra Nevada. These roof pendants are uneroded portions of the rock mass which covered the deep chamber in which the granitic magma (molten rock) slowly cooled. Through the latter part of the Jurassic Period and through the Cretaceous Period, numerous granite-like magmas were intruded at great depth. The slowness of the cooling is evidenced by the large mineral grains.

Following the Cretaceous Period, almost everywhere in the world, was a prolonged period of erosion. The Tertiary Period, which is represented in some areas (as the Ventura Basin) by several tens of thousands of feet of sediments, is poorly represented in the Mono Basin. Whereas the entire Tertiary Period lasted about 70 million years, the oldest Tertiary rocks in the Mono Basin are only about 12 million years old, or Pliocene.

Quaternary Glacial History

The glacial history of the Mono Basin has been studied for more than 100 years. There is still not complete agreement on the sequence and age of the glacial moraines which are the main evidence of past glacial activity (Gath, 1984). Russell (1889) recognized that there had been more than one glacial advance and in his report is an excellent drawing of the glaciers tributary to the Mono Basin when Lake Russell was at elevation 7060 (Plate XXIX), as well as sketches of moraines in Lundy Canyon (Plate XXXI), Bloody (Walker) Canyon (Plates XXVI and XXXVII), and a detailed topographic map of the moraines of Parker and Bloody (Walker) Canyons (Plate XXXV).

One of the continuing problems in glacial studies of the Sierra Nevada has been to correlate these mountain glaciations with the standard sequence of Pleistocene continental glaciers in midwestern United States, which, from youngest to oldest is as follows:

Wisconsin
Illinoian
Kansan
Nebraskan

In his classic 1931 paper on glaciation of the eastern Sierra Nevada, Blackwelder proposed that the two most obvious moraines be correlated with Wisconsin glaciers, with Tahoe as Early Wisconsin and Tioga as Late Wisconsin. He recognized no Illinoian moraines but assigned the Sherman moraines to the Kansan and the McGee moraines to the Nebraskan. Sharp and Birman (1963) inserted Tenaya as a Wisconsin stage between Tahoe and Tioga, and recognized a Mono Basin moraine as equivalent to the Illinoian. Their Mono Basin lateral moraines are shown on Russell's (1889) Plate XXXV as being overridden by the high Tahoe lateral moraines of Bloody (Walker) Creek.

With the development of radiometric age-dating in the 1960's, a powerful tool became available for determining actual ages of glacial tills associated with volcanic rocks. Curry (1966) found an old till (McGee) lying upon a basalt age-dated as being 2.6 million years old. In the Deadman Pass area an even older till was found to be between 2.7 and 3.1 million years old. Considering that the start of the Pleistocene is commonly given as 2 million years ago (Table 1) it is reasonable to conclude that these tills are at least as old as Nebraskan. Another possibility is that the Ice Age actually started earlier in the mountains of western United States. The Sherwin till is much younger than the McGee till; where buried by the Sherwin till, the McGee till has a soil zone which is estimated to have taken at least 100,000 years to develop prior to burial (Gath, 1984). The Sherwin till is generally considered a Kansan equivalent. It is overlain by the Bishop Tuff which has been age-dated by the K/Ar method (Dalrymple and others, 1965) and by the fission-track method (Izett and Naeser, 1976) as being 700,000 years old.

Increasingly, Pleistocene glacial chronology is being referenced to oxygen-isotope studies of deep-sea cores (Shackleton and Opdyke, 1973, 1976). The major glaciations were accompanied by a lowering of ocean temperatures which is reflected by some of the organisms living in the ocean. Certain species of foraminifera, an abundant microscopic animal, leaves a calcareous shell which is preserved in the deep oceanic muds. Studies of oxygen isotopes in these cores has allowed the construction of a curve of ocean temperatures vs. time over the last 750,000 years. Such a curve (Colman and Pierce, 1981) recognizes 10 different glacial stages over the last 700,000+ years, and has been used by Gath (1984). It is included here as Figure 5.

Another useful methodology has to do with the earth's polarity, which has reversed itself at intervals over geologic time. Such polarity is preserved by certain minerals deposited in sedimentary rocks and in certain minerals formed in cooling lavas. The present polarity is called Brunhes Normal, which goes back about 1 million years; prior to that is Matuyama

Reversed (Bowen, 1978). The key to the time of this change of polarity (world-wide) is the age of the Bishop Tuff, which is the oldest known volcanic rock with Brunhes Normal polarity. The careful age-dating of the Bishop Tuff at 700,000 years has established a minimum age for the Brunhes-Matuyama polarity change (Dalrymple and others, 1965). More than 20 volcanic rock units with radiometric ages between 1.0 and 1.6 million years belong to the Matuyama reversed-polarity epoch.

Gath (1984) has shown a glacial correlation in his Table 1, which is reproduced as Figure 5 in the present report. The age of the Bishop Tuff strongly supports assigning the Sherwin to the Kansan. Note that the Brunhes-Matuyama contact depicted by Gath is a minimum age, and could be as great as 1 million years.

Gath suggests that Tioga moraines are of Late Wisconsin age and would fall in Stage 2 from 13,000 to 32,000 years ago. The Tenaya would fall in Stage 4 which is Early Wisconsin (64,000 to 75,000 years ago). Because the Tahoe moraines are so large, he reasons that they must be associated with a major glacial advance (Stage 6 - Illinoian) rather than with the relatively minor Stage 4 advance. Gath notes (p. 54) that the Mono Basin stage, while not specifically removed, seems to have been gradually incorporated with the Tahoe stage. One must wonder from this diagram what was happening in the Sierra Nevada from 200,000 to 700,000 years ago. Curry (1971) has proposed a Casa Diablo stage about 400,000 years ago, which would make it Illinoian. Curry's Casa Diablo till is sandwiched between two basalt flows for which there are single

K/Ar dates for the overlying and for the underlying flow. Bailey and others (1976) sampled the same basalt flows and got much smaller ages; they assigned the Casa Diablo till to the Mono Basin stage. It would appear that much additional work will be required before the glacial chronology is settled. The oxygen isotope curves are relatively featureless beyond 800,000 years and will not be helpful for the Early Pleistocene.

Volcanic History

Reference to the geologic map (Plate 3) will show that volcanoes were active in the Mono Basin in the Permian Period about 250 million years ago (Table 1). Another episode of volcanic activity occurred during the Triassic and Jurassic, at about the same time as the massive Sierran batholith was being emplaced. Igneous rocks are usually classified on the basis of silica content and grain size. In general, igneous rocks which have cooled slowly from a deep-seated molten mass (magma) have large crystals. If the magma reaches the ground surface it is called lava, and because it cools very quickly, it either develops no crystals (glass) or very tiny crystals. A simplified classification for igneous rocks (from Lipshie, 1979) is given in Figure 6. The Permian, Triassic, and Jurassic volcanic rocks were all heavily metamorphosed by heat and pressure during the emplacement of the Sierran batholith. West of Mono Lake, these old rocks are included in the Log Cabin Mine roof pendant (Plate 2).

There appear to be no rocks of Early Tertiary age in the Mono Basin. They were either never deposited, or deposited and then subsequently removed by erosion. The oldest known Tertiary rocks, as reported by Gilbert and others (1968, p. 284), were found near Cowtrack Mountain, southeast of Mono Lake. The K/Ar dates would place them in the Miocene Period. North of Mono Lake the volcanic rocks are somewhat younger (9 million years old) and are considered Early Pliocene. There was widespread volcanic activity in the Mono Basin in the Late Pliocene between 2 and 4 million years ago. The relationships of these rocks suggest that most of the major faulting and warping which shaped the Mono Basin took place prior to the eruption of this series.

For the Quaternary, the volcanic history has been studied intensively. To understand the volcanic events in the Mono Basin, we must start farther south, in the Long Valley area. If we look at Figures 7 and 8, which are from Bailey (1982), we can see what is suggested as a common magmatic source for the earlier volcanic eruptions in the Long Valley area and the later volcanic eruptions in the Mono Basin.

The rhyolites of Glass Mountain (Figure 7) were erupted over a long period of time (0.9 to 1.9 million years ago) along a ring fracture which was later to become a part of the boundary of the Long Valley caldera. Bailey (1982, p. 19) suggests that the Glass Mountain rhyolites represent the earliest leakage of magma from the Long Valley magma chamber.

About 700,000 years ago in Long Valley, a catastrophic eruption occurred which produced a volume of volcanic materials much greater than any which has been recorded in historic time. Airborne volcanic ash and hot pyroclastic flows amounted to a volume of about 125 cubic miles of solids. This is to be compared with less than 1 cubic mile of pyroclastic materials in the May 18, 1980 eruption of Mt. St. Helens. The Long Valley eruption is believed to have occurred during a short space of time -- a few hours to a few days. The material erupted has been called the Bishop Tuff (Gilbert, 1938b). The ash from this eruption spread over a large area of the western United States -- to southeastern Idaho, southern Wyoming, western Nebraska and Kansas, El Paso, Texas, and Ventura, California (Miller and others, 1982; Sarna-Wojcicki and others, 1984). Pyroclastic clouds of hot pumice buried an area of at least 580 square miles to depths of ten to hundreds of feet. These deposits were so hot that they were remelted to form a welded tuff or ignimbrite. The Bishop Tuff crops out a few miles south of Mono Lake (Plate 2). In the subsurface it has been found at depths of about 1300-1600 feet in the deep well drilled on Paoha Island in 1908 (Gilbert and others, 1968), in the Cain Ranch water wells, and in the Mono Craters Tunnel (Putnam, 1949) where it is at least 500 feet thick. To the south, it forms the extensive tableland north of Bishop and is an important aquifer tapped by many water wells beneath the Bishop alluvial cone. The eruption of the Bishop Tuff partially evacuated the magma chamber, causing the collapse of the roof and the formation of a caldera about 10 miles wide, 16 miles long and 2 miles deep. Subsequent to the collapse of the caldera, the depression was filled to two-thirds of its depth, so that the present topographic relief is only about one-third of its original depth.

Following the sudden collapse of the Long Valley caldera, upward moving magma is believed to have been the cause of a slow upward bulging of the central part of the caldera and the formation of a resurgent dome (Figure 7). This slow upward bulging, which is dated as between 680,000 and 630,000 years ago, was accompanied by rhyolitic eruptions from at least 12 different vents (Bailey and others, 1976). The central dome was surrounded by a ring-shaped valley referred to as a moat.

The Mammoth earthquakes of May 1980, along with a surveyed rising of the resurgent dome, caused much concern about the possible resumption of volcanic activity in the Long Valley caldera, and the potential for an eruption of the magnitude of the Bishop Tuff event (Miller and others, 1982).

Starting about 500,000 years ago, there were three distinct episodes of rhyolite eruptions in the moat -- at 500,000 years ago, 300,000 years ago, and 100,000 years ago -- suggesting some periodicity. At a later stage (180,000 years to 50,000 years ago) there were rim eruptions of rhyodacite (also called quartz latite, Figure 6), which produced Mammoth Mountain (Figure 7).

The eruptions of basalt occurred mainly to the west and showed a progressive movement toward the north with time (Figure 7). The basalts in the Devil's Postpile area and the west moat area have K/Ar ages ranging from 200,000 to 60,000 years ago (Bailey, 1982). The basalts near June Lake are younger (Curry, 1971). The Black Point eruption has a radiocarbon date of 13,500 years (Lajoie, 1968).

The Mono Craters are quite young geologically, as they started erupting only about 40,000 years ago. They consist of about 30 rhyolite domes in an arcuate chain, and are probably related to ring fractures (Figure 7). The similar Inyo Craters are believed to have erupted along a fracture system connecting the magma chamber underlying the Long Valley caldera with another magma chamber underlying the Mono Craters (Figure 8). Using hydration-rind dating, Wood (1977a) has shown that the volumetric rate of extrusions in the Mono Craters has increased dramatically in the last 10,000 years and that in the last 2,000 years, eruptions have occurred every 200-300 years. For these younger lavas, the K/Ar method is not used, and age-dating relies more on radiocarbon determinations on wood fragments in the flows and in tephra deposits, and on tree-ring studies.

The Inyo Craters started erupting less than 12,000 years ago. The ash beds are chemically distinct from those of the Mono Craters, and none were found in the deposits of Lake Russell (Wilson Creek formation of Lajoie, 1968). Miller (1985) has suggested that the earliest eruption of the Inyo Craters (a rhyolite dome with no explosive activity) occurred about 6000 years ago. Dalrymple (1968) obtained a K/Ar date of 3900 BP (before present) for a dome near the southern end of the chain. Radiocarbon years, expressed as BP, are related to the 1950 AD datum. They are converted to sidereal years (AD) by means of the curve developed by Stuiver (1982). Miller (1985), using tree-ring studies, believes the last eruption of the Inyo Craters was just a year or two prior to 1369 AD. The products of this eruption (South Deadman tephra) clearly overlie the products of the last Mono Craters eruption (North Mono tephra) which Sieh and Bursik (1986) believed occurred between 1325 AD and 1365 AD.

The latest volcanic activity in the Mono Basin occurred on the islands in Mono Lake (Stine, 1984). Many of these eruptions were in the last 220 radiocarbon years. The keys to deciphering the volcanic history of the Mono Lake islands are three ashes from eruptions of the Mono Craters at about 600 BP, 1200 BP, and 2000 BP, and a shoreline developed about 220 BP. The "platform" of Negit Island is the oldest as it is overlain by the 2000 BP ash. The "middle flow" is overlain by the 600 BP tephra and an older dacitic (?) ash. The "eastern flow" is covered by the 600 BP ash but no older tephra units. Two flows ("western" and "young") have no mantle of 600 BP ash and are therefore younger than the last eruption of the Mono Craters in 1325 AD - 1366 AD. The "young" flow post-dates the 220 BP shoreline (Stine, 1984).

Two Negit islets -- Twain and Java -- appear to be the source of an eruption of pumice blocks which are abundant along the northwest shore of the lake. One radiocarbon date combined with stratigraphic information places the date of this eruption at about 1500-1700 BP. Little Norway is overlain by the 600 BP ash, as well as 20 younger dacitic ashes. Stine (1984) believes these dacitic ashes are derived from eruptions on Paoha Island.

Because of the absence of a shoreline at Elevation 6456, Stine (1984) believes that Paoha Island did not exist at 220 BP, and estimates that it emerged sometime between 1720 AD and 1850 AD. This emergence was accompanied by at least 20 eruptions which produced dacitic ashes.

Quaternary Basin Fill Deposits

Sedimentary rocks older than Quaternary are uncommon in the Mono Basin (Gilbert and others, 1968; Lee, 1968). Some are shown east of Mono Lake on Plate 3. They are interbedded with lava flows age-dated as 3-4 million years, which puts them in the Pliocene. Their maximum thickness is about 300 feet. They include sands and gravels and lake beds containing fossil molluscs and fish. The animals lived in a fresh-water lake with possible inflow from the north (Lahontan Basin) and outflow to the east or south. This lake basin was topographically lower than the area now occupied by Mono Lake. Gilbert and others (1968) suggest that either the structural depression now occupied by Mono Lake did not exist at that time, or it was filled with alluvial fans that were built eastward from the Sierra Nevada.

Lajoie (1968) has suggested that a lake has occupied at least the center of the basin for the last 500,000 years. In the well drilled on Paoha Island in 1908 the top 1000 feet were lake beds. It is believed that the Bishop Tuff (which is 700,000 years old) was penetrated in this well at a depth of about 1400 feet. About 900 feet of lake beds were found in the geothermal well drilled east of Black Point in late 1971 (Axtell, 1972). The volcanic activity which caused the emergence of Paoha Island resulted in a doming of the beds deposited in the bottom of the lake. This doming exposed the Wilson Creek formation deposited during the Tioga glacial stage and exposed about 300 feet of the pre-Wilson Creek lake sediments. Lajoie (1968) believes the oldest exposed lake beds are about 170,000 years old. All of the pre-Wilson Creek beds have a radiocarbon age greater than 35,000 years.

Trace element studies of several ash beds in these older lake beds suggest that each layer was derived from a separate source, and that none of them came from the Mono Craters. This is consistent with radiocarbon data indicating that these beds were deposited before the Mono Craters started to erupt. The doming of the lake beds has sloped the bedding planes toward the lake, producing instability and the movement of massive slide blocks into the water. About 32,000 years ago some lake silts were deposited beneath the Rush Creek delta, which would make them intermediate in age between the old lake beds and the Wilson Creek formation. Trace element correlation indicates that an associated ash bed came from the Mono Craters.

Underlying the Holocene deposits is a widespread lake bed sequence which has been studied in great detail by Lajoie (1968) and named by him the Wilson Creek formation. It is completely exposed along Wilson Creek just west of Black Point, where it is 22 feet thick. The upfolded sequence on Paoha Island is 41 feet thick; elsewhere in the Mono Basin it is as much as 50 feet thick. At the type section along Wilson Creek, the formation consists primarily of light gray, finely laminated clayey silts interbedded with 19 distinct rhyolitic ash layers. Each ash layer represents a separate eruption of the Mono Craters as confirmed by trace element analysis. The individual ash layers range in thickness from 0.0015 to 0.35 foot; the cumulative thickness is 2.2 feet. The thickness and grouping of the ash layers are very distinctive, so that in those places where only a part of the Wilson Creek formation is exposed, it is possible to determine where within the total sequence the exposed beds lie. Along Wilson Creek, near the top of the formation, is a thick (8-20 foot) bed of dark brown basaltic cinders which resulted from the eruption of Black Point volcano. This eruption is believed to have taken place about 13,300 BP when the lake was at elevation 6880 (Lajoie, 1968; Christensen and Gilbert, 1964). The only fossils found in the Wilson Creek formation are calcareous types (ostracodes) and siliceous types (diatoms). Ostracodes collected from two layers were age-dated as 13,300+/-500 BP and 18,900+/-700 BP. Using these dates and the intervening rate of sedimentation, the Wilson Creek formation was estimated to have been deposited between 23,000 and 12,500 years ago (Lajoie, 1968). Older lake beds were found below the Wilson Creek formation in the Lee Vining delta test hole below a depth of 90 feet. These are probably of Tahoe age.

During the Quaternary, especially since the Bishop Tuff was erupted 700,000 years ago, the pattern of deposition was much the same as it is today. Deltaic sediments originating in the Sierra Nevada extended into Lake Russell, tending to move downslope into the basin as lake levels fell, and to retreat as lake levels rose. When lake levels rose, the expanding area of lake beds covered the previously deposited deltaic sands and gravels. To the east of the lake, aeolian forces prevailed, redistributing the pumiceous sand from eruptions of the Mono Craters and earlier volcanic centers.

Since about 1980, there have been very detailed studies of the Holocene stratigraphy of the Mono Basin. Stine (1984) has concentrated on the fluctuations of lake levels over the last 3500 years using radiocarbon dates and the known dates of the later eruptions of the Mono Craters. Lajoie (1968) focused on the Wilson Creek formation (Tiogan). Much work remains to be done on the hiatus between 11,000 and 2,000 years ago.

It is to be hoped that detailed studies similar to the one recently completed by Sieh and Bursik (1986) could be expanded to earlier eruptions of the Mono Craters. From numerous natural exposures and excavations, these authors mapped the thickness and distribution of the North Mono tephra, resulting from the last eruption of the Mono Craters in about 1325 AD - 1365 AD. This tephra was earlier referred to as the 600 BP ash. Eight airfall beds consitituted the opening episode of the eruption, with some contemporaneous and subsequent deposits from pyroclastic flows and surges. These were followed by non-explosive domes and coulees in the North Mono Craters area. The last episode was a sequence of events at Panum Crater, which erupted through the delta of Rush Creek. In the initial phase, the throat-clearing breccia contained many water-rounded pebbles and cobbles from the delta. This was followed by a dune flow deposit developed southwest of the vent, which was then covered by a series of pyroclastic surge beds. A much coarser block-and-ash flow deposit was laid down north of the vent toward Mono Lake. The final major pyroclastic episode was the eruption of the tephra ring of Panum Crater within which Panum Dome was extruded.

The recently completed bathymetric and geophysical survey of Mono Lake by Pelagos Corp. (1986) has presented some data which probably relate to the North Mono eruption. Sub-bottom profiling has revealed a number of reflector beds, some of which are trace-able over large areas. One of these reflectors is believed to be an ash layer five to six feet below the present lake floor which locally traps upward migrating gas. Ash layers are indicated on most of the 13 geologic cross-sections.

The detailed bathymetry will offer a powerful new tool to researchers interested in unraveling the late geologic history of the Mono Basin. It will be especially valuable if combined with additional SCUBA diving to observe bottom features, and with coring of the bottom sediments. Even a cursory examination of the bottom topography raises some interesting questions. Which of the linear features are fault lines? Do the lines of small mounds represent tufa towers along fault lines? Was Rush Creek formerly flowing in a more easterly course and was it diverted to its present course by the Panum block-and-ash flow described by Sieh and Bursik (1986)? Was the deep channel cut by Rush Creek during a very low stand of the lake in the Tioga-Tahoe interglacial? The answers to these and many other questions would probably come from a detailed analysis of the new bathymetry as correlated with exposed surface features.

IV. GROUND WATER HYDROLOGY

Occurrence of Ground Water

The major aquifers in the Mono Basin are associated with the deltas of the large streams issuing from the Sierra Nevada. There are few water wells in the Mono Basin so the shallow aquifers are poorly known. To help correct this deficiency, in the summer of 1980, a test well was drilled by LADWP on the delta of Lee Vining Creek. It was drilled to a depth of 262 feet from a ground surface elevation of about 6442. The primary objectives were hydrologic -- to determine gross aquifer-aquiclude relationships. Three observation wells were also drilled, but to shallower depths (Figures 10 and 11). The wells are drilled with cable-tools, and because of caving difficulties, it was necessary to use bentonitic mud. The observation wells were used in a pump test for aquifer characteristics and to monitor the effects of flow in Lee Vining Creek.

In the summer of 1980, Stine (1984) began a study of the Late Holocene stratigraphy of the Mono Basin, and in the summer of 1981, Sieh and Bursik (1986) started to study the latest eruption of the Mono Craters. In August 1984, at the Mono County Marina, a core hole was drilled to a depth of 33 feet; the log is given in Stine (1984, pp. 32-33). The 2000 BP ash(?) is shown at a depth of about 55 inches; above that are mostly beach sands. Below the 2000 BP ash(?) to the total depth of the core hole is a "biogenic ooze" -- basically a lower permeability lake bed sequence. As the elevation of the ground at this point is 6381, this lake bed sequence would be found between elevations 6377 and 6348. Stine relates this lake bed sequence to the "Holocene highstand" of the lake, which ended about 3500 years ago. In the Lee Vining Creek delta test hole, the first thick clay sequence was encountered between depths of 17 and 36 feet, or between elevations 6425 and 6406. Stine indicates that the lake level during the Holocene highstand was between elevation 6490 and 6500, so it is possible that this 19-foot clay layer may represent deposits of the Holocene highstand. If this interpretation is correct, then below a depth of 36 feet there should be earlier deltaic deposits related to the dry period between the end of the Pleistocene and the Holocene highstand, then the Wilson Creek formation, then deltaic deposits of the Tenaya-Tioga interglacial. It would take careful coring along with several radiocarbon dates in order to unravel this sequence.

Regardless of the exact geologic age of this sequence, the western part of the basin fill, adjoining the Sierra Nevada, must consist of alternating layers of deltaic deposits and lake beds to coincide with the documented changes in level of the Holocene and Pleistocene lakes. Furthermore, the deltaic deposits must pinch out in a downgradient direction and the lake beds must thin upgradient. This is essentially the picture painted by Lee (1969, p. 87). The most recent deltaic deposits (after the Holocene highstand) are basically an unconfined aquifer. However, in the non-deltaic areas -- the predominantly sandy areas in the eastern part of the lake shore -- thin, fine-grained ash deposits are probably present, corresponding to the 2000 BP ash, the 1200 BP ash, and the 600 BP ash. These could be of low enough permeability to develop low artesian heads between them. The defluidization structures described by Cloud and Lajoie (1980) may be related to such low head artesian conditions. The presence of such structures close to the Mono Craters, where the airfall deposits would be the thickest, lends support to that suggestion. The low permeability of ash deposits in the bottom sediments of Mono Lake is suggested in the Pelagos (1986) report. A widespread thin ash deposit five or six feet below the present lake floor appears to cause a local trapping of upward migrating gas.

Even greater artesian heads would be expected beneath the thicker mid-Holocene lake bed sequence and the Wilson Creek formation. Just west of Black Point, the coarse gravels beneath the Wilson Creek formation are exposed by the downcutting of Wilson Creek. Prior to the downcutting, those gravels probably contributed to the artesian heads involved in the formation of the tufa towers southwest of Black Point. The continuing large flows in this area suggest an even deeper artesian aquifer than the one exposed in the bottom of Wilson Creek. Except in the deltaic areas, the clastic deposits developed during low stands of the lakes tend to be sandy with little or no artesian head.

Recharge to Ground Water

Recharge to the ground water of the Mono Basin may be classified into three categories, all of which originate as rain or melting snow: (1) percolation to the Holocene unconfined aquifer along streams originating mainly in the Sierra Nevada; (2) direct penetration of rainfall and melting snow on surfaces of the Holocene unconfined aquifer; and (3) direct percolation of rain and local surface runoff into fractured rocks along the western edge of Mono Lake.

Streambed percolation is greatest along streams which originate in large, high elevation watersheds with high rainfall. These include Rush Creek, Walker Creek, Parker Creek, Lee Vining Creek, Mill Creek and Wilson Creek. Streams which do not originate in the Sierran block have much lower flows because rainfall decreases rapidly in an easterly direction, and also because porous soils throughout most of the rest of the basin favor immediate percolation rather than prolonged surface flow. In the eastern areas of windblown pumice sand, surface flows are uncommon.

Direct penetration of rainfall to ground water increases as average annual rainfall increases but decreases with increasing clay content of the soil (Mann, 1957). Glacial moraines and tills have a high clay content and a high water-holding capacity. Water which enters such clayey soils tends to penetrate only to shallow depths from which it can later be removed by the native vegetation. Only in wet years would the amount of rainfall be more than the water-holding capacity of the soil so that the excess would be available to move down to the water table.

In the eastern areas where the surfaces are characterized by wind-blown sands, heavy rains may cause water to move downward because the water-holding capacity of clean sands is very low and there may be little perennial vegetation. Deep movement may be hindered by the young ash flows and by lake bed sequences such as that related to the Holocene highstand, or by the Wilson Creek formation. Such water tends to "ride" on these low permeability layers and move slowly toward the lake. Where there is no sandy veneer, essentially all of the rainfall is evaporated from the clayey surfaces.

The straight north-northwesterly-trending shoreline of Mono Lake between the Lee Vining Creek delta and Mono City represents an unusual hydrogeologic condition (Figure 12). These drainage areas consist exclusively of hard fractured granitic and metamorphic rocks. Rain, melting snow, and local channeled runoff are able to flow directly into exposed fractures or those covered by coarse permeable rubble. A particularly favorable circumstance for recharging these fractures is the blanket of alluvium (Qal) which occurs on the uplifted block (Plate 3). Once underground, the water is able to move through a complex set of fractures until it is forced to the ground surface.

As a general rule, hard fractured rocks with little soil will allow a high percentage of the rainfall to become recharge. Where this water moves into adjoining alluvial materials without appearing as spring flow it is referred to by Feth (1964) as "hidden recharge". There is certainly some recharge in this category on the large areas of volcanic rocks which surround the Mono Basin. Relatively, however, the total amount of recharge is small because these areas lie in the rain shadow of the Sierra Nevada and the average annual rainfall is very low.

Disposition of Ground Water

Almost all of the ground water of the Mono Basin is disposed of by evapotranspiration within the Mono Basin or is evaporated from Mono Lake. The only exception is the ground water which originates from rainfall in the watershed of the Mono Basin but which flows into the Mono Craters tunnel and becomes part of the flow of the aqueduct.

Some ground water never reaches the lake but is consumed by evapotranspiration in the watershed areas where small springs emerge. Along the Mono Lake fault zone (Bryant, 1984) ground water is forced to the surface along a prominent feature which has offset Tahoe moraines.

The ground water which circulates by the shallowest path is that which originates as deep penetration of rainfall or percolation of local runoff and moves toward the lake within the unconfined aquifer. Lee (1969), using some pump test information and a flow-net analysis estimated that this amounts to only about 240 acre-feet per year.

By far the largest amount of ground water which reaches Mono Lake travels through relatively shallow confined aquifers. The main conduits are believed to be the Early Holocene aquifer and the Tahoe-Tioga interglacial aquifer. In the Black Point area, an even deeper aquifer seems to be the source of the spring flow.

Springs

Russell's Report

The earliest information on springs in the Mono Basin is to be found in the report of I. C. Russell (1889). The locations of the springs found during Russell's investigation are shown on his Plate XVII. Most of the springs are plotted close to the shoreline but many (especially north of the lake) are at higher elevations in the former bed of the Pleistocene lake. Note that on his Plate XVII Russell has indicated a lake elevation of 6380 feet; later surveys have shown that the actual elevation in 1883 was close to 6410. On the east side of the lake, Warm Spring and Tufa Crags are shown to the east of the railroad, whereas now they are west of the railroad embankment. It is unlikely that their position has changed; this may be a misplot.

Russell has made no attempt to enumerate the springs in detail. He notes that many small springs are probably of local origin; these he classes as "hillside springs". He recognized that some of the springs rose from great depths and termed these "fissure springs". He makes the observation that nearly all the springs are either in the bottom of the lake or quite near its shores, and that they occur in the greatest abundance near the base of the mountains. He found only three springs that had temperatures noticeably above the normal. He was not certain about the nature of the springs rising from the bottom of the present lake, but suggests that they might be thermal because of the vapors rising from the lake surface in cold weather. Later studies by Keenan Lee (1969) do not support Russell's theory; almost all of the sublacustral springs are cool.

Russell bathed in Warm Spring on the east shore of the lake, estimated its flow as 10 gpm, and its temperature as between 80°F and 90°F. He sampled the water and had it analyzed. The water had a salinity of about 2000 parts per million, dominantly sodium carbonate.

At the southeast corner of Paoha Island in Hot Spring Cove he measured the temperature of one spring as 110°F, and another as 96°F. The second spring had a salinity of less than 1000 parts per million.

Near the northwest corner of the lake, Russell noted a line of springs related to Holocene faulting near the base of the hills about 3 miles northwest of the lakeshore. Temperature and salinity were both low. It is not certain which springs Russell was referring to in this description.

Russell observed that large springs flowed out of tufa crags, some of which were subaerial and some sublacustral. He recorded that these waters were cool and of low salinity. He observed the shallow mounds produced on the lake surface by upflowing spring waters and also spring flow cascading into the lake from springs exiting at the top of tufa towers which rose above the lake surface. An analysis of one of these natural fountains showed salinity of less than 300 ppm.

Russell understood the mechanism of tufa formation -- that the calcium was carried into the lake by the streams from the Sierra Nevada and that it was caused to be deposited by the highly alkaline waters of the lake.

Early Spring Surveys

In the early 1930's, private littoral rights on Mono Lake were acquired by condemnation in the Los Angeles v. Aitken case. Because of certain claims made in that case, a monitoring program was started, involving both springs and wells. This was a limited monitoring program directed primarily toward springs and wells on the lands of the defendants in the condemnation action. It was continued until a more comprehensive program was started in 1979. During the Aitken case, considerable testimony was presented on the flows of springs, water levels in wells, and chemical analyses, the last directed toward the usability of the waters for various types of consumptive uses. The Aitken testimony and exhibits are being studied for integration into the present spring survey data.

Keenan Lee Report (1969)

Keenan Lee made a comprehensive study of springs and wells in the Mono Basin as a Ph.D. dissertation in the Geology Department at Stanford University. He described all known wells and took water samples where possible. He mapped the water table around the lake with the help of hand augering and shallow seismic surveys. The map appears as his Plate 2. From a flow net analysis, he estimated that the flow to the lake within the shallow unconfined zone was only 240 acre-feet per year. This constituted only a negligible portion of the total ground water contribution of 39,500 acre-feet per year which he estimated from water budget studies. Keenan Lee classified the springs as: (1) basin springs; (2) shoreline springs; and (3) offshore springs. He sampled 36 springs, noting temperature and pH, and measured the rate of flow. From general mineral analyses, he classified the waters as to types (Figure 18) and showed that calcium bicarbonate waters were derived primarily from the Sierra Nevada and sodium bicarbonate waters were typical of the eastern areas.

Current Spring Survey

The current spring survey was started in 1979. The objectives were to locate previously identified springs, to search for additional springs, and to determine which, if any, may have dried up. The Mono Lake shoreline was divided into seven subareas (Figure 19). Between October 1979 and July 1982, eight surveys were conducted and a photo record was begun for each site. A map of springs was prepared (Figure 19A). As each spring was visited for the first time, the flow rate, water temperature and electrical conductivity were measured, and samples of the larger springs were collected for chemical analysis. The names and locations of springs surveyed are given in Appendix C. In subsequent visits, flow rate, water temperature, and electrical conductivity were measured. In general, no re-sampling was done unless the temperature and/or electrical conductivity was changed. However, in 1986, a broad re-sampling was done for repeat chemical analysis.

Types of Springs

The springs of the Mono Basin can be conveniently classified into the following types:

1. Upslope springs
2. Lakeshore water table springs
3. Deltaic artesian springs
4. Deep fracture artesian springs
5. Fractured rock gravity springs

Upslope Springs

Upslope springs are those which exit at points remote from Mono Lake. Their most important characteristics are: (1) relatively low flow; and (2) the water is consumed by evapotranspiration in the vicinity of the orifice and they do not contribute water to Mono Lake. Where the springs are of local origin and related to the surfacing of a local water table, they are usually of excellent quality. The high elevation Ranchera and Murphy Springs, which are higher than the shoreline of Pleistocene Lake Russell, have total dissolved solids of 115 and 103 parts per million, respectively. The lower level Burkham Springs have somewhat higher total dissolved solids (189 and 186 ppm) and have higher sodium, apparently from pumiceous debris originating in the Mono Craters. The warmer springs, which usually are higher in salinity, tend to appear close to the lake because the driving heads on these systems are more likely to cause flows at the lower elevations than at the higher elevations. Thus Warm Springs are tributary to the lake because they occur along a fault which happens to be pass close to the lake shore. Except for these circumstances it would be possible to find higher elevation warm springs which would not be tributary to the lake.

Lakeshore Water Table Springs

The occurrence of lakeshore water table springs can be explained by reference to Figure 9. Basically, such springs are found in the shallowest permeable deposits and are related to a true water table. Such free ground water will tend to "ride" on an underlying low permeability layer, which might have been formed at different geologic times at different places along the lake's periphery. In non-deltaic areas, the free ground water could be underlain by one or more of the recent ash layers (600 BP, 1200 BP, or 2000 BP). The effect of such layers might be the generation of small artesian heads at a depth of only a few feet. The defluidization structures on the south shore of Mono Lake were attributed to upflowing artesian waters by Cloud and Lajoie (1980). The confining layer most likely responsible for the development of this artesian head is the 600 BP ash from the adjacent North Mono craters eruption. In this vicinity, the total thickness of airfall deposits from this eruption is given by Sieh and Bursik (1986, Fig. 4.) as about 40 inches. The same airfall deposit may extend beneath Mono Lake and constitute the seismic reflector discovered by Pelagos (1986) in their recent bathymetric survey. The reflector occurs at a depth of 5 to 6 feet below the present lake floor and is of such low permeability that it is able to form local traps for upward migrating gas. Recently drilled shallow test holes on the north and east shores of the lake indicate low artesian pressures at depths of less than ten feet. The most likely confining layers for such artesian heads are young ash flows. Along Wilson Creek west of Black Point, cauliflower-like deposits of tufa exposed in the canyon wall appear to have been developed by upflow of water from such a shallow artesian layer. In the deltaic areas in the western sector of the shoreline, the confining ash layers have probably been drained by erosional downcutting.

Below the 2000 BP ash the next important low permeability layer is the lakebed sequence related to the Holocene highstand. In some places, this may serve as the layer on which the free ground water "rides". In the core hole at the Mono County Marina, Stine (1984) found this layer between depths of less than 5 feet to the total depth of the hole at 33 feet. In the Lee Vining delta test hole which was drilled by the LADWP in the summer of 1980, the free ground water lies above a clay layer which was penetrated between depths of 17 and 36 feet. It is not known at this time whether that clay layer is the same as the one found in the Mono County Marina core hole, or whether it is the older Wilson Creek formation. In shoreline areas beyond the extent of the Holocene highstand clay layer, the free ground water would be expected to "ride" on the Wilson Creek formation, which is related to a much higher lake level.

Regardless of the low permeability layer on which the free ground water "rides", the permeable layer in which such water is moving toward the lake will pinch out in a downgradient direction, force the water to the ground surface and produce a spring or seepage area.

Deltaic Artesian Springs

The largest springs in the Mono Basin are or were artesian. They are related to the deltaic deposits of the large streams which originate in the Sierra Nevada -- Rush Creek, Lee Vining Creek, Mill Creek, and Wilson Creek. As shown diagrammatically in Figure 9, the permeable deltaic deposits must pinch out in the downgradient direction and are thus "dead-end" aquifers. When lake levels fall, the sands and gravels move farther down into the basin. When lake levels rise, the sands and gravels are blanketed with new lake beds. Throughout the later Pleistocene and early Holocene, as the level of Lake Russell alternately rose and fell, a series of "dead-end" aquifers was produced. In each of these there was a build up of artesian head; this would tend to cause a back up of ground water which would then "spill" into the water table aquifer. In this area of active faulting, the artesian pressure was able to escape where the overlying clay layers were fractured (Figure 13). The largest artesian springs occur in the central and western portions of the lake, where there are delta deposits and where the faulting has been the most active. The recent bathymetric survey of Pelagos (1986) shows many bottom features oriented along lines trending about North 20 degrees West. This is parallel to the prominent fault scarp followed by Highway 395 north of Lee Vining.

From the pattern of tufa pinnacles, it would appear that the deltas of Rush and Mill Creeks were more extensive than at present. South Tufa suggests that the delta of Rush Creek formerly extended considerably to the east of its present position, and this suggestion is supported by the recent bathymetric survey which shows a sublacustrine channel far to the east of the present channel of Rush Creek. This channel comes up no higher than elevation 6340 and extends below elevation 6280. The present channel of Rush Creek ends in a canyon which doesn't quite reach elevation 6320. The easterly channel may represent a lake level lower than any previously recorded. The shift of the channel from its easterly to its present position appears to be related to the Panum block-and-ash flow deposit which was erupted to the northwest of Panum Crater about 600 years ago. This sudden event blocked Rush Creek and diverted it to its present course. Stine (1984) suggests that at the time of this eruption, Mono Lake stood at an elevation of 6406. He also suggests that the prominent wave-cut bench which appears on this deposit at elevation 6456 is related to a high stand of Mono Lake about 220 BP.

The eruption of Panum Crater came up through the delta of Rush Creek as the rounded cobbles of igneous and metamorphic rocks in the ejecta will attest. South Tufa is probably related to artesian flows in older deltaic deposits of Rush Creek. The explosive products of Panum Crater would completely overlie these deltaic deposits, and would have had little impact on the artesian flow paths. The rhyolite plug occupying the throat of Panum Crater, however, may have partially blocked the artesian flow paths from the present Rush Creek to South Tufa. Similarly, the eruptive products of Black Point appear to have covered the deltaic deposits of Wilson Creek. Also, the basaltic vent may have blocked some of the artesian flow paths in the older deltaic deposits on the north side of the lake.

An interesting problem of tufa tower distribution is their absence in the central portions of the existing deltas of Lee Vining and Rush Creeks. The artesian aquifers should be present as well as the faults to allow the escape of the artesian water. It is possible that the confining clay beds have been breached by stream erosion such as can be seen along the lower reaches of Wilson Creek. Another possibility is that some tufa towers were formed but removed by erosion as lake levels fell and the streams assumed different courses in forming the delta.

Deep Fracture Artesian Springs

Deep fracture artesian springs represent waters which have circulated deep within the earth and have risen to the ground surface along a conduit which is most probably a fault. The sources of these waters are obscure; however, they are believed to be predominantly rain water which has entered the ground at higher levels and traveled a long and deep flow path before emerging at the ground surface. Studies of hydrogen and oxygen isotopes have been made by Mariner and others (1977) for three hot springs near Mono Lake -- one on the south shore, one on the north shore, and one on Paoha Island. The springs on the north and south shore have a deuterium composition similar to that of nearby fresh waters, meaning they are derived from meteoric (rain) water. The higher salinity hot spring on Paoha Island appears to be a mixture of relatively fresh meteoric water and lake water.

All of the hot springs are located in the middle portion of the basin, in the belt along which the volcanic eruptions have taken place. They exit at relatively low topographic positions where the driving artesian head would tend to be at a maximum.

Chemically, the waters of the deep fracture artesian springs are different from the artesian waters which have followed a shallower flow path. Because they are of higher temperature and because they have had a longer exposure to rock surfaces, they are more mineralized. Many of them contain dissolved gases such as methane, carbon dioxide, hydrogen sulfide, or nitrogen. The hot spring near South Tufa has a temperature of about 94°F and a total dissolved solids (TDS) of about 2000 parts per million (ppm). Mariner and others (1977) have determined that the abundant gas in this spring is carbon dioxide. The hottest springs in the Mono Basin are found at the southeast corner of Paoha Island. They have temperatures as high as 167°F and may be almost as saline as lake water. Mariner and others (1977) believe that these springs result from a mixture of lake water and local fresh water which has circulated through a deep, thermal path. Isotopic ratios lie between those of local fresh waters and that of Mono Lake water. The gas in the hot spring water on Paoha Island consists of about 70 per cent methane and 25 per cent nitrogen.

Hot waters are also found on the north shore of Mono Lake east of Black Point. Solo Hot Tufa Tower Spring has a temperature of 122°F and a short distance to the south, Jamie Hot Tufa Tower Spring has a temperature of 131°F. Both have salinities of about 3000 ppm. Similar hot (149°F) water flows from the Dechambeau well.

Two geothermal wells were drilled in 1971 -- one near the hot spring on the south shore (State PRC 4397.1), and one near the hot spring on the north shore (State PRC 4572.1). Both wells reached hard granitic or metamorphic basement rocks. Temperature surveys run in these wells indicated little potential for geothermal development and the holes were abandoned.

Warm Springs, at the eastern shoreline of the lake, rises along a north-south fault. The temperature is only slightly elevated (90°F) and the TDS is about 2100 ppm.

Fractured Rock Gravity Springs

The mechanism of fractured rock gravity springs is shown diagrammatically on Figure 12. This unusual hydrogeologic condition is best developed on the steep fault scarp just west of Highway 395 north of Lee Vining. The uplifted fault block consists of hard granitic and metamorphic rocks which have been extensively fractured. Rain, melting snow, and local channeled runoff are able to enter exposed fractures. On the flat tableland west of the scarp the fractures are fed by an extensive blanket of saturated alluvium (Plate 3). The recharge follows interconnected fracture systems until it is forced to the ground surface. Some fracture systems daylight on the slope above Highway 395 and support areas of vigorous phreatophytes. In addition to the fracture systems there are other high permeability paths in talus deposits and landslide debris. The Mono Lake fault zone (Bryant, 1984) closely follows Highway 395 and may restrict the easterly flow of ground water. There is much evidence of Holocene movement along this fault. The role of this fault in acting as a conduit to carry ground water north from Lee Vining Creek was the subject of much testimony in the Los Angeles v. Aitken case.

Ground water which is not forced to the surface to the west of Highway 395 is able to flow through talus and landslide deposits which underlie the highway. As there are no important deltaic deposits in this reach, the ground water quickly encounters low permeability lake beds and is forced to the ground surface. There are numerous springs just east of the highway. These springs would be expected to be very sensitive to runoff from the small drainages of Log Cabin Creek and Andy Thom Creek because of the potential for short, highly permeable flow paths. However, the flow paths are long enough to produce a mineral content noticeably above that of the associated surface waters.

Changes in Spring Flow

Theoretically, springs might show changes in temperature, flow rate, or chemical characteristics. However, most springs in the Mono Basin have relatively long flow paths, which would promote stability in temperature and chemical characteristics.

The most changeable feature is expected to be the flow rate. Deltaic artesian springs tend to have large flows through open conduits; the conduits are often extended vertically upward within tufa towers. Flows in such pipe-like systems would be very sensitive to pressure changes in the confined source aquifer. Specific causes of lowered pressure would be: (1) reduction of lake water level over the top of the head-controlling tufa tower; (2) change of flow exit from the top of the tufa tower to the base of the tufa tower; or (3) exposure of the confined source aquifer by erosional downcutting, such as has occurred along the lower reaches of Wilson Creek. An increase in pressure could be related to a rise in lake level similar to that which happened in the early 1980's. Under such circumstances, the head in the confined source aquifer would rise and cause an increase in the flow of those upslope springs whose source is the same aquifer.

Deep fracture artesian springs would be most susceptible to changes due to major earthquake events. Flows might show an increase or a decrease. Such springs, over time, would tend to have a reduction of flow related to mechanical and/or chemical clogging.

Springs with low flows and large surface pools may suggest seasonal temperature changes. These changes, however, are more likely related to changes in air temperature. The temperature at the orifice will probably show much less variability.

The fractured rock gravity springs east of Highway 395 would appear to be the most susceptible to short period changes. With short, highly permeable flow paths, such springs should respond to heavy runoff events with appreciable increases in flow. Temperature and chemical changes would probably be of a lower magnitude. In some instances, there might be direct runoff of surface waters into the spring course, which would point up the advisability of an upstream investigation where a sharp increase in flow is measured.

There are few old records with which to compare the measurements being taken in the present systematic spring survey which was started in 1979. It may be difficult to determine if the spring being measured now is for the same orifice as noted in the past. For example, Russell (1889, page 288) estimated the flow of a warm spring near the eastern edge of Mono Lake as 10 gallons per minute (gpm). Actually, there are several warm springs in this vicinity. Warm Spring B in August 1986 had a flow of 22 gpm.

The Villette Spring (sometimes called the Mono Vista Spring) has a long record of flow measurements. Observations on this spring, which emerges from the base of a large tufa tower, were made as early as 1934 during compilation of evidence for the Los Angeles v. Aitken case. The defendant upon whose property this spring is located was J. O. Veillet. The testimony from both sides supported a minimum flow at that time of 1.5 cubic feet per second (cfs), which is about 675 gpm. The early flows of the Villette Spring have been studied by Mason (1967). He noted that monthly flow measurements for this spring showed less than a 1 per cent variation from steady flow (8.25 per cent of the annual flow per month). In his Figure 13, Mason has plotted the July 1 lake level against the total yearly flow of Villette Spring (calendar year), and concluded that there was a primary dependence of spring output on lake level elevation. He also concluded that there is a secondary influence of rainfall on the spring flow which is delayed a year. As the lake level fell during the period 1958-65, Mason personally observed that several springs on shore near Villette Spring went dry. During the same period he observed that a number of new sublacustrine springs developed offshore from those which had become extinct. Based on the 1936-61 data, he predicted that Villette Spring should cease to flow in the summer of 1971. The latest measurements (in 1986) show a flow of about 1.5 cfs. He suggested two possible explanations for the three-fold increase of Villette Spring in early 1963: (1) a rise in lake level; or (2) a change in weir configuration. The latter explanation is probably the correct one. Villette Spring has been measured by LADWP hydrographers on a monthly basis since January 26, 1959. Early in 1963, the lessee of the nearby house plugged the throat of the measuring plume to create a small pond. Currently this pond feeds an intake to a pipe serving the domestic needs of the house as well as the suction intake of a County booster station. Some of the flow measurements are excessively high because they were taken soon after the plume was unplugged and included the release of water stored in the pond. More recent measurements avoid this problem by arranging for the unplugging of the plume 24 hours in advance of the measurement.

Mason paints a picture of aquifer discharge points (springs) moving downslope as the lake level falls and upslope as the lake level rises. The cessation of flow from the tops of tufa towers is well documented; after a tufa tower has emerged as the lake level falls, the flow is commonly from the top of the tower. It appears to be the normal evolutionary process for the flow to move from the top to the base. In the late 1970's, a tufa tower near Villette Spring had a small flow out of the top. By early 1980, the flow had stopped. Whether this is related to a pressure reduction or to mechanical/chemical clogging may be difficult to say. Assuming fairly constant recharge to single confined source aquifer, it would be reasonable to assume that the cessation of outflow at higher discharge points would result in an increase in flow at the lower discharge points. Similarly, a rise in lake level would be expected to cause an increase in flow from the higher discharge points.

Tufa Deposits

No discussion of the springs of the Mono Basin would be complete without a discussion of tufa deposition, and its most spectacular manifestation, the tufa pinnacles. These features were noted by the early travelers and were discussed at great length by Russell (1889). From earlier work in the Lahontan Basin, he was familiar with the three distinct types of tufa -- lithoid, dendritic, and thinolitic. Lithoid is a stony variety which usually forms the core of a tufa tower. The core is surrounded by layers of dendritic (branching) tufa. The shell, except for the surface layer, is made of crystalline thinolite. Because of its diverse crystalline form, the thinolite has received considerable attention. Russell's Plate XXVI shows the numerous forms the crystals of thinolite can assume. This country's foremost mineralogist made a comprehensive study of thinolite (Dana, 1896). Lajoie (1968, Plate 5) has made a thorough study of the tufa of the Mono Basin -- its lithology, occurrence and distribution, mode of formation and age.

There has been some controversy in the literature concerning the origin of tufa. Dunn (1953) favored a purely chemical origin, whereas Scholl and Taft (1964) thought that algae have had an important to dominant role in tufa formation. Cloud and Lajoie (1980) suggest that there is general agreement that the basic mechanism is physiochemical, with local algal activity influencing only form and surface texture. There is ample evidence that both processes are important. Algae often coat the wet surfaces of exposed tufa towers. Pelagos, as part of the recent bathymetric surveys, made dives at several places in the lake, and found algae growing on many submerged tufa surfaces.

Tufa consists mainly of calcium carbonate, and is a special type of limestone deposited from spring waters. In many areas of the Great Basin of western United States the presence of ancient springs is recorded by massive terraces of tufa. The deposition of calcium carbonate from solution is a very common geological process. Almost all rocks contain some calcium, which in the presence of water and carbon dioxide, goes into solution as calcium bicarbonate. Anywhere in ground water, the calcium bicarbonate tends to stay dissolved because the pressure is above that of the atmosphere and the carbon dioxide gas remains in solution. When such waters emerge as springs into an environment of lower pressure, the carbon dioxide gas comes out of solution and a solid deposit of calcium carbonate is produced. In normal (subaerial) spring deposits, the calcium carbonate forms thin layers on the surface over which the spring water flows.

In Mono Lake, the process is different. When waters with dissolved calcium come in contact with the alkaline (high sodium and potassium) and carbonate-rich waters of the lake, calcium carbonate is deposited. Although most of the calcium is derived from waters (surface or ground) coming from the Sierra Nevada, any calcium-bearing water reaching the lake could produce a deposit of calcium carbonate. An example of the latter would be the tufa deposits near Warm Spring at the east shore of the lake. Three fairly distinct modes of deposition may be recognized. Where fresh surface waters flow into the lake, there is a slow mixing with the heavier lake water, with the production of tiny calcium carbonate particles which can be transported around the lake by winds and currents. These tiny particles will tend to form coatings on rock and gravel surfaces. The tendency of the fresh tributary inflow to "ride" on the heavier lake water and to mix only very slowly was recognized by Keenan Lee (1969). The role of such hypopycnal inflow in the formation of tufa was discussed by Stine (1984). A second form of tufa deposition occurs where diffuse shallow waters come in contact with lake waters. The fresh waters could be free ground waters reaching the lake as seepages downgradient from tufa tower outflow. Such a mechanism may explain some of the widespread cemented beach gravels. Another type of diffuse cementation would be represented by the escape of shallow artesian waters such as those which produced the defluidization structures of Cloud and Lajoie (1980).

The above horizontally layered tufa deposits are to be contrasted with tufa pinnacles which are caused by focused deposition. Almost all the large pinnacles are found in the delta areas of the streams which originate in the watersheds of the Sierra Nevada, especially Rush Creek, Lee Vining Creek, Mill Creek, and Wilson Creek. Waters of these streams percolate into their permeable beds and move downward into confined aquifers, dissolving calcium along their flow paths. The pressurized water is able to move upward through the confining lake clays and to the bottom of the lake at places where the clays have been breached by faulting. If the velocity of upward escape is great enough, the artesian flow may produce a crater on the bottom of the lake. Keenan Lee (1969, page 68) found two sublacustrine springs exiting at the bottom of conical pits off Danburg Beach. The normal depth of water at the time of his observations was 16 to 17 feet. These pits extended another 38 to 40 feet below the normal lake bottom. The most likely explanation is that the walls of the pits were developed in the Wilson Creek lake beds, and the bottoms of the pits (both at about the same elevation) exposed the top of the Tahoe-Tioga interglacial aquifer. A similar pit was exposed during a low stand of the lake in 1981. It was designated as the Danburg Beach Spring.

The flow was measured as 4 cfs (1795 gpm). The recent bathymetry by Pelagos shows lines of circular features in the central and western parts of the lake bottom. The trends are mostly about North 20° West. Some of the features are mounds and some are depressions. These may be spring orifices marked by low tufa towers or by shallow pits.

The normal expression of a sublacustrine spring orifice is a tufa tower, where calcium carbonate is deposited where the exiting fresh spring water comes in contact with the alkaline lake water. As these deposits accumulate, the spring orifice is extended upward as a tube or tubes within the tufa mound. Such tubes may be as much as 5 feet across. If the artesian pressure is great enough, the tufa pinnacle might grow up to the surface of the lake. As the development of tufa pinnacles is exclusively a sublacustrine process, they can not grow above the surface of the lake. Russell (page 290) noted "natural fountains" -- tufa towers whose tops were higher than the lake surface and were discharging fresh water -- and recognized that these represented a recession of lake levels. For some years after lake levels have declined and the tufa tower has emerged it may continue to discharge water from its orifice at the top. Some deposition of tufa may continue as water moves down the outside surface of the tower. The formation of this aerobic coating would probably involve algal activities. When the tufa tower is completely exposed to its base, it has lost the hydrostatic support formerly provided by the high density lake water. So long as the water flows out of the top of the tufa tower, the base is subjected to an interior hydrostatic pressure equal to the height of the tower, which might be 40 feet or more. This internal hydrostatic pressure, coupled with deterioration of the tufa due to exposure to air, may explain why some (and perhaps all) tufa towers develop a breach near the base through which the artesian water can escape. Where tufa towers have a common pressurized source aquifer, the change from discharge at the top of the tower to the base of the tower would be expected to bleed off the pressure in the source aquifer. Nearby towers may cease to flow from the top, and there may be a partial drainage of the source aquifer in the recharge area. Once this partial drainage has been accomplished, outflow from the tower bases would tend to stabilize at a rate equal to average recharge, with perhaps some fluctuations related to wet and dry periods. Mason (1967), in a study of Villette Spring, has suggested an increased inflow due to a wet year, but with a one year lag. The continuing flow from the tower bases tends to recharge the water table aquifer and to extend the grassy areas downslope as the lake recedes. This appears to have happened in the Mono Vista area.

Not all tufa pinnacles are related to deltas. Any sublacustrine spring with a substantial flow of calcium-bearing water could produce a tufa tower. The lake has such an abundance of available carbonate so as to react with any dissolved calcium which reaches it. Thus we find tufa crags on many of the ancient and relatively recent shorelines. Most of the tufa crags at higher elevations no longer have actively flowing springs. In most instances, this means a reduction of head in the feeding artesian systems. Another explanation might be mechanical or chemical clogging.

In Appendix C is given an alphabetical list of springs in the Mono Basin for which there is some evidence of existence. Those that have been located in the field by the LADWP are part of the present systematic spring survey. An attempt has been made to correlate those with the springs located and sampled by Keenan Lee in the 1960's. No such attempt has yet been made for those on the BLM list. Where there are many springs in the same area, such as the 8 springs in the County Park in the southeast quarter of Section 19, it may be very difficult to know exactly which spring was observed, sampled, or measured, especially where old springs are drying up and new ones are appearing. Further attempts at the correlation of these data will be made during 1987.

V. SURFACE WATER HYDROLOGY

Precipitation

The average annual precipitation in the Mono Basin ranges from less than 6 inches on the valley floor (at the eastern edge) to greater than 30 inches at the topographic divide of the Sierra Nevada on the western side of the watershed.

Precipitation occurs predominantly as snow, and over two-thirds of the average annual precipitation occurs during the months of November through March. Summer thundershower activity results in high intensity precipitation at times, but adds only a small amount to the total water supply of the area.

A summary of precipitation stations in the Mono Basin has been prepared (Table 2). The location of each station is indicated on Figure 14. Data have been recorded for some stations on a continuous basis from the early 1930's to the present. The longest periods of record (starting in 1925) are from the stations at Gem Lake and Ellery Lake. Precipitation records since 1931 are available at the Cain Ranch Station.

The earliest precipitation data in the vicinity of the Mono Basin were recorded at the mining town of Bodie from 1895 to 1906. Bodie, which averaged 14.5 inches per year for this period, is at elevation 8,200 feet and is located just northerly of the Mono Basin watershed boundary. Additional data for the Bodie area were obtained during the period 1965-68 (Table 2).

An isohyetal map (which shows lines of equal precipitation) was prepared using data from nine precipitation stations and four snow courses in the Mono Basin area (Figure 15). Only three precipitation stations have complete records for the period 1940-76, but data from all the stations (as extended by correlation techniques) were used as a guide in constructing the isohyetal lines.

After the isohyetal map was constructed, the Mono Lake watershed was divided into smaller tributary sub-watersheds, and average annual rainfall amounts were calculated for each sub-watershed. The average precipitation for the total watershed was calculated to be 12.4 inches per year. In the hill and mountain areas, the average was 15.6 inches, and on the valley floor, the average (excluding Mono Lake) was 9.6 inches (Table 5). An average of 8 inches per year is estimated to fall directly on the Mono Lake surface.

Surface Runoff

Surface runoff from the hill and mountain areas within the Mono Basin watershed occurs largely from the melting snowpack during the spring and summer of each year. The calculated average annual hill and mountain runoff is approximately 167,000 acre-feet (Table 5). Over 85 percent of the total is measured. Table 3 shows the annual amounts of measured runoff from the hill and mountain areas, which is the combined total of Lee Vining, Walker, Gibbs, Parker, Rush, and Mill Creeks. Note that the average annual amount of measured runoff for the 1941-76 period was about 142,000 acre-feet and for the 1941-85 base period was 148,000 acre-feet; the remaining 25,000 acre-feet per year was from ungaged areas and was estimated.

All of the gaging stations used to measure surface runoff are located on the western side of the basin near the base of the mountains (Figure 14). In Table 4 for all the gaging stations, there is shown the period of record, location of station, and the average runoff for each station for the period of record and for the periods 1941-76 and 1941-85. The largest flows have occurred in Rush Creek (average of 60,900 acre-feet or 85 cfs), and the second largest in Lee Vining Creek (average of 48,300 acre-feet or 68 cfs). DeChambeau Creek had the smallest average measured flow (approximately 800 acre-feet or 1 cfs, Table 4).

In order to estimate the amount of runoff from areas which are not gaged, an annual runoff amount was calculated for the entire hill and mountain area. First, average rainfall amounts were calculated using the isohyetal map (Figure 15). The Mono Lake watershed was then divided into sub-watersheds areas and acreages were planimetered. A weighted-average precipitation value was calculated for each tributary area from the isohyets. Average runoff was determined by applying a percentage to the weighted average precipitation. The percentages were derived from similar watersheds where the runoff is measured.

As noted earlier, Mono Lake derives the principal portion of its water supply from the streams that flow from the eastern slope of the Sierra Nevada. The lake constitutes the ultimate sink for all undiverted surface flow or groundwater underflow within the basin. Numerous perennial springs near the shore and underneath the lake surface contribute considerable inflow to the lake. Only a portion of these flows can be measured.

The source of this groundwater inflow is rainfall within the Mono Basin watershed, which percolates along the beds of the flowing streams or enters fractured basement rock in the hill and mountain areas.

Water Imports and Exports

For many years, water has been imported into the northern portion of the Mono Basin from the East Walker River drainage area. Approximately 2500 to 3000 acre-feet per year is diverted from Virginia Creek at a point approximately 0.5 mile west of Conway summit, and then flows into the basin through Conway Summit Pass to the Conway Ranch, where irrigation ditches distribute the water to sheep pastures. The diversion is made under water rights adjudicated and confirmed in Federal Court Decree C-125 (California DWR, 1960, p. 42).

The most northerly point in the Los Angeles Aqueduct System is the Lee Vining Intake. This is the beginning of the Mono Basin Extension, where water from Lee Vining Creek (including Gibbs Creek water) is diverted into the Lee Vining-Grant Lake Conduit. The waters of Walker Creek and Parker Creek are also diverted into this conduit, except for some irrigation water which is allowed to flow in overheads across the conduit. Smaller flows of South and East Parker Creeks. Bohler Canyon, and DeChambeau Creek (totaling about 4 cfs) are not diverted. Mill Creek, which is north of the Lee Vining Intake and not part of the Aqueduct System, is not diverted and flows into Mono Lake. Mill Creek is the third largest stream tributary to Mono Lake (Table 4).

Rush Creek, with an average flow of 85 cfs (years 1935-85) is the largest stream in the Mono Basin. It flows into the June Lake Loop (June Lake to Gull Lake to Silver Lake) and then into Grant Lake Reservoir (capacity 47,500 acre-feet). After temporary storage in Grant lake Reservoir, which is used to regulate flow, the diverted waters of the Mono Basin are exported to the Owens River in Long Valley through the Mono Craters Conduit and Tunnel, or are released from Mono Gate #1 into Rush Creek, thence toward Mono Lake.

The flow from Grant Lake Reservoir in the Mono Craters Conduit is measured at the Grant Lake outlet tunnel control shaft by a Venturi tube, equipped with a Bailey meter. Daily records began on April 9, 1941. Diversions were made through this outlet tunnel and out of Mono Gate #1 to Rush Creek as early as March 16, 1940.

The export from Mono Basin is calculated by subtracting the measured releases at Mono Gate #1 from the total measured flow out of Grant Lake. This differential is commonly referred to as "Flow to West Portal" (Table 6). Exports by Los Angeles began during the water year 1940-41. They averaged 56,900 AF/yr during the period 1941-70, and about 87,200 AF/yr during the last seventeen years (1970-86).

VI. WATER QUALITY

Previous Water Quality Studies

During his early survey of the Mono Basin, Russell (1889) took several water samples to be analyzed by T. M. Chatard in the Washington Laboratory of the United States Geological Survey. He intentionally took no samples of the tributary streams, noting (p. 287):

> "No chemical analyses of these waters have been made, but they have, without question, the normal purity of mountain streams."

The samples of Warm Spring on the "northeastern" side of the lake showed a total dissolved solids (TDS) of 2.0692 grams per liter. The flow was about 10 gallons per minute (gpm) and the temperature between 80° and 90°F. His Plate XVII shows Warm Spring at the extreme eastern edge of the lake near the old Bodie and Benton Railroad. The spring he sampled is probably one of those currently being monitored by LADWP. Russell discussed a thermal spring at Hot Spring Cove on the eastern side of Paoha Island but did not sample it. On the west shore of Hot Spring Cove, the Petroleum Spring, so-named because of its odor, had a temperature of 96°F and a TDS of 0.8775 grams per liter. Water from one of the tufa tower springs (natural fountains), whose top rose above the lake surface, had a TDS of only 0.2918 grams per liter. Russell took two samples of lake water at a point 1.7 miles northeast of Paoha Island at depths of 1 foot and 100 feet. The sampling point is indicated by the letter "y" on Plate XIX. He selected this location because he saw no evidences of sublacustrine springs in this vicinity. A mixture of the two samples was considered more representative than either sample, and upon analysis showed a TDS of 53.4729 g/l. Russell recognized that Mono Lake was rich in alkaline carbonates which were derived from the large areas of volcanic rocks in the watershed. He suggested that Mono Lake might become a commercial source of sodium carbonate.

The next analysis of Mono Lake water was probably not until 40 years later, as reported in Clarke (1924). It showed a TDS of 51.17 grams per liter in a lake whose level was about 15 feet higher than in 1883.

In the early 1930's, several chemical analyses were made for presentation as testimony in the Aitken case, which involved the condemnation of the private littoral lands around Mono Lake. One of the questions was the "highest and best use" which could be supported by the water available to those lands. A sample of lake water showed a TDS of about 50,000 ppm. Charles H. Lee (1924-35) was a witness for the City of Los Angeles. Based upon the planned diversions by the City, he predicted the decline of lake levels to a point of stabilization -- where the inflows and evaporation were in balance. After laboratory experiments with Mono Lake water, he developed a relationship between the specific gravity of the brine and the rate at which it evaporated as compared with fresh water. Drawing upon his long-term experience with Owens Lake, he concluded that Mono Lake would reach a stabilization level before the salinity got high enough to cause the deposition of salts.

In the early 1930's, there was considerable interest in the possible commercial recovery of salts from the Mono Lake brine. A sample taken on July 16, 1930 by the Pacific Alkali Company showed a TDS of 46.9569 grams per liter (Black, 1958).

As reported by Black (1958), the flooding of Owens Lake in 1937-40 generated a great deal of interest in the commercial recovery of salts. There was much testimony on this subject in the Natural Soda Products case. Following that trial, the Division of State Lands, LADWP, and the commercial salt operators participated in the joint sampling of both Owens Lake and Mono Lake. Surface samples from four parts of Mono Lake were taken on September 26, 1937, showing TDS in the range of 52.714 to 53.567 grams per liter. Other samples were taken in the 1940-55 period. As of 1948, there were two operators attempting to recover salts from Mono Lake brines.

Since the early 1930's, selected streams, wells, and springs have been monitored by hydrographers of the LADWP (Tables 10 and 11). The California Department of Water Resources sampled six wells in the Mono Basin in 1960 (Table 11). The first comprehensive water quality study in the Mono Basin was that of Keenan Lee (1969). He collected 63 water samples from 60 different sources -- 36 from springs, 21 from wells and auger holes, five from surface streams, and one from Mono Lake. Most of his locations are shown on Figure 19A. More generalized chemical studies were undertaken by Mason (1967) in conjunction with a limnological investigation of Mono Lake. Mason compared the results of nearly 50 chemical analyses of Mono lake water to arrive at a "most probable" chemical composition.

As environmental concerns grew in the 1970's, there came a need for a better understanding of the salinity of Mono Lake, especially in three dimensions. In 1974, an extensive sampling program was conducted at many locations, at different depths, and at different seasons (Table 13A). A similar, but less comprehensive sampling program was carried out in 1979 (Table 13B).

The first hydrological model of the Mono Lake system was that of Loeffler (in Winkler, 1977). Loeffler worked with lake salinity in two ways. First, with a view toward correcting the evaporation rate as salinity increased, and second, as a means of predicting lake salinity in the future as lake levels dropped. The correction to the evaporation rate was the same method that had been developed by Charles Lee in the early 1930's.

During the 1970's, interest in geothermal development led to an investigation of the hot springs of the Sierra Nevada, including the Mono Basin (Mariner and others, 1977). These authors sampled the hot springs of Paoha Island, the hot spring on the south shore of Mono Lake, and one of the hot springs on the north shore of Mono Lake east of Black Point. These sophisticated studies included the determination of hydrogen and oxygen isotopes of these waters. From the isotope studies, the authors suggest that the hot springs on Paoha Island and the hot spring on the south shore required the mixing of lake water with thermal or fresh water before the fluid came to the surface.

In 1979, LADWP started a comprehensive spring survey to expand on the limited program which had been started in the early 1930's. The objectives were to locate previously identified springs (especially those of Keenan Lee), to search for additional springs, and to improve the data base on chemical quality and flow rates. The Mono Lake shoreline was divided into seven sub-areas (Figure 19). Between October 1979 and July 1982, eight field surveys were conducted. The locations of the springs investigated were plotted on a photomosaic of colored aerial photos flown on March 28, 1980 (Plate 1). As each spring was identified, the flow rate, temperature, and electrical conductivity were measured, and a sample was taken for chemical analysis. In 1982, a survey of springs in the Mono Basin was made by the U. S. Bureau of Land Management. Those springs appear on the alphabetical list in Appendix C, but have not yet been visited by LADWP personnel. A compilation of water quality data on wells and springs in the Mono Basin is given in Tables 11 and 12. The wells and springs located as of 1981 are shown in Figure 19A. An updated (1986) location map for wells and springs was prepared (Plate 6).

Surface Waters

The surface waters of the Mono Basin are of very low salinity and are excellent for drinking. This is not surprising because they originate as rain falling on granitic and metamorphic terranes. Representative analyses are given in Table 10. TDS values are almost always below 100 ppm, and are commonly below 50 ppm. The salinity remains very low even at very low flows. The higher salinities of Bridgeport Creek are explained by the fact that the samples are taken after the water has passed over several miles of valley fill deposits. Note in Table 10 that the highest values among the cations are usually for calcium. It is this calcium in the streams emanating from the Sierra Nevada which reacts with the abundant carbonate of Mono Lake to precipitate the deposits of tufa.

Groundwaters

Well Waters. There is little use of water from wells in the Mono Basin. Small amounts are used for domestic purposes and for stock watering. Chemical analyses for essentially all the wells in the Mono Basin are given in Table 11. Because such waters have a slow flow path in the subsurface and a longer contact time with mineral grains, they have a higher mineral content than the associated surface streams which are the source of their recharge. Nevertheless, the TDS values are usually under 500 ppm. The Dechambeau Well (#213) is a deep well which flows hot (65.5°C) water. It is on the important thermal trend which passes through Paoha Island and is probably fed by a deep fracture. Such waters, as this, are characterized by elevated TDS and a very high percentage of sodium. WWN2 is a shallow auger hole in the unconfined aquifer. The very high salinity is related to lake water left behind as Mono Lake receded. WWE7 and WWE10 are shallow auger holes which also show some influence of lake waters. The Paoha Well (#601) is the flowing well which was drilled as an oil test in 1908. It is not highly mineralized. The high calcium indicates little contribution from lake water. The Tyree 217 Well (#515) draws water from old lake beds where contact time has been very long.

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Spring Waters. In contrast with the few wells in the Mono Basin, springs are widespread and of diverse chemical character. Their cumulative contribution to Mono Lake is on the order of several tens of thousands of acre-feet per year. The flow of many can be measured, but many exit at the bottom of the lake where the flow can not be measured. Keenan Lee made dives with SCUBA equipment on four sublacustrine springs in attempts to sample them at their orifices. The samples he obtained were almost as saline as lake water.

The various hydrogeologic explanations for the presence of springs in the Mono Basin were discussed in Chapter IV. Chemical analyses of the numerous springs which have been located and sampled are given in Table 12. Locations are shown on Figure 19A and on Plate 6.

From the results of his extensive sampling and chemical analyses, Keenan Lee developed a map of water types (Figure 18). Waters originating from rainfall in the Sierra Nevada are of the calcium bicarbonate type and are distributed in the western part of the Mono Basin. The springs in the eastern areas are of a sodium bicarbonate type, reflecting the influence of the young ash deposits of the Mono Craters. Between the two main types of waters are others which probably reflect contributions from deep fractures and on Paoha Island, from Mono Lake. All of the springs with higher temperatures have elevated concentrations of dissolved minerals. They have probably circulated to considerable depth where higher temperatures promote the solution of minerals. The hot waters usually have a high sodium percentage and high boron and fluoride. The springs with large flows are mostly of lower temperatures and have lower salinities.

Mono Lake Water

Chemical Character. The chemical character of Mono Lake water can be ascertained from the selected analyses presented in Tables 13A, 13B, and 14. Mono Lake is one of a unique group of very alkaline lakes that exist in the dry regions of the world. Among alkaline lakes, it has been classified as a "triple-type", which designation refers to a distinctive class of natural waters whose chemical composition includes notable quantities of three ions -- carbonate, sulfate, and chloride. Waters of this type are further characterized by very low concentrations of calcium and magnesium. The lake's high alkalinity (pH = 9.6 or higher) is related to the high concentrations of the carbonate ion. There is a high degree of uniformity in chemical composition in Mono Lake, both horizontally and vertically, and throughout the year. This uniformity is promoted by factors such as high winds which cause mixing, and thermal currents. An exception to the picture of uniformity is the Danburg Beach sector, where large volumes of fresh water enter the lake through tufa tower springs (exposed and submerged).

Trend of Total Dissolved Solids. As the level of Mono Lake has fallen from its historic high in July 1919, the volume of the lake has decreased, its area has decreased, and its salinity has increased. Since the start of diversions by the City of Los Angeles, the salinity has increased from about 48,000 parts per million (ppm) or 48 parts per thousand (ppt) in June 1940 to 87,000 ppm (87 ppt) in March 1980 (Table 14). As of early 1987, the lake level is 5 to 6 feet higher than it was in 1980, so that it is now less saline than it was in 1980.

Evaporation Rate as a Function of Salinity. It is a well-established fact that the evaporation rate (inches per year) of a saline lake decreases as the salinity of that lake increases. This was established by laboratory experiments by Charles H. Lee in the early 1930's. Lee also developed a relationship between the evaporation rate of Mono Lake and the specific gravity of the lake water. He used this relationship in predicting at what level the lake would stabilize in the future, assuming continuing exports by the City of Los Angeles. Lee's equations were adopted by Loeffler in his early model (Winkler, 1977) and by Vorster in his model (Vorster, 1985). They are also used in the Mono Lake Hydrologic Model discussed in the present report. Lee's equations are given on page IX-8.

TDS vs. Specific Gravity. The modeling procedures used by Loeffler, Vorster, and LADWP incorporate the projection of lake specific gravities as a means of predicting future lake levels. These specific gravities can be converted into TDS if the relationship between these two parameters is known. Much confusion has resulted from uncertainties over the units used to express the TDS. LADWP measures and records TDS levels in milligrams per kilogram (mg/kg, or ppm) which is a weight-to-weight relationship. A more convenient unit is parts per thousand (ppt) which allows the use of smaller numbers. Another common means of expressing TDS is grams per liter, which is a weight-to-volume relationship. In reporting chemical analyses of fresh waters, the mg/kg (ppm) and mg/l values may be used interchangeably because a liter of fresh water weighs one kilogram. In saline waters such as Mono lake, however, a liter of the brine weighs considerably more than one kilogram, and the weight-to-weight and weight-to-volume values for TDS are not interchangeable. To eliminate this source of confusion, the relationships shown in Figures 29 and 30 have been developed. They have been determined from laboratory evaporation of samples of Mono Lake water. The conversions between mg/kg and mg/l are simple:

> To obtain mg/l from mg/kg, multiply the mg/kg value by the specific gravity.
>
> To obtain mg/kg from mg/l, divide the mg/l value by the specific gravity.

Projection of Future Salinities. It is important to note that the Mono Lake Hydrologic Model does not project salinities. It projects lake specific gravities from which salinities are calculated. The equation used for calculating TDS is given on page IX-9. Note that it assumes that the weight of salts dissolved in the lake will remain constant at 285 million tons. Black (1958) noted that the calculated tonnage of salts in Mono Lake remained within the range of analytical error while the lake volume changed by 20 per cent. Mason (1967, p. 67) stated that Mono lake had shown no gain or loss of dissolved ionic content since 1882. He didn't consider this surprising when considering the small magnitude of additions of ions from the streams. The total amount of sodium accumulated since 1882 fell within the analytic scatter of the results. This concept of a constant weight of dissolved salts is also used in the Loeffler and Vorster models. The figure of 285 million tons was determined from the average of the 1940-80 values shown on Table 14. As shown in the equation on page IX-9, the TDS in ppm is calculated from the model-predicted lake volume and the specific gravity. Based upon the early experiments of Charles Lee and his knowledge of Owens Lake, he was of the opinion that there would be no deposition of salts prior to the stabilization of Mono Lake.

VII. MONO LAKE WATER LEVEL FLUCTUATIONS

Fluctuations in Geologic Time

Lake Russell is the Ice Age predecessor of Mono Lake. It existed during the latter part of the Pleistocene in a closed basin centered about where Mono Lake is located now. In the early part of the Pleistocene, before the eruption of the Bishop Tuff about 700,000 years ago, the history of the lake is not clear. However, in the deep well drilled on Paoha Island in 1908, the top 1000 feet were found to be lake beds. Lajoie (1968) estimated a depositional rate of about 2 feet per thousand years and suggested that the 1000 feet of lake beds found in the Paoha Island deep well took about 500,000 years to be deposited. The lack of saline deposits in this sequence of lake beds was taken as an indication that the lake had never evaporated to complete dryness. From these facts and assumptions, Lajoie postulated a continuous body of water, at least near the center of present-day Mono Lake, for the last 500,000 years.

Based upon radiocarbon dating of ostracodes, Lajoie found 32,000 year old lacustrine silts beneath the Rush Creek delta deposits which in turn underlie the Wilson Creek formation. During the deposition of these silt layers, Lajoie suggests that Lake Russell rose above elevation 6660. Subsequent to deposition of the silt layers and prior to the highstand related to the Wilson Creek formation, the lake level dropped below elevation 6640. Wilson Creek time represented a prolonged period of dominantly high lake levels, probably corresponding to the Tioga stage of the Late Wisconsin. Lajoie's suggested lake level fluctuations during Wilson Creek time are given in his Figure 19. An important radiocarbon date (21,900 years BP) was found for lithoid tufa from the elevation 7070 terrace near the overflow channel from the Mono Basin into Adobe Valley. This may have been about the time of the last overflow of Lake Russell, and the development of the highest terrace at about elevation 7180. During Wilson Creek time, the level of Lake Russell probably did not fall below elevation 6600. An important time marker is the eruption of Black Point, radiocarbon dated as 13,300 years BP. This eruption occurred beneath Lake Russell when the lake elevation was 6880, as determined from basaltic debris in deltaic deposits on the Sierra escarpment. Because of the unusal type of weathering of the basalts on the top of Black Point, it was concluded that Black Point must have been exposed to the air after the eruption, which means that the lake level must have fallen. Furthermore, the lake level must have risen again to allow the deposition of lithoid tufa on the walls of the narrow crevices which are found on the top of Black Point. From a study of the distribution of thinolite tufa at various elevations, believed by Lajoie to have been deposited in response to increasing salinity in Lake Russell, he suggests a rise in lake level to above 6900 feet prior to the major drop in lake level which coincided with the end of Wilson Creek time.

There has been little study of the early part of the Holocene, marked by the relatively dry conditions which followed the high lake levels of Wilson Creek time. There was some downcutting in the alluvial fans emanating from the eastern front of the

Sierra Nevada. Fine-grained material contributed to the biogenic ooze which continued to accumulate in the deeper parts of the lake. The driest period was the so-called "altithermal" from about 7500 to 4000 years ago.

The period between 3500 years ago and the present time has been studied primarily by Stine (1984). His Figure 1 is reproduced herein as Figure 28. He concludes that following the altithermal between 7500 and 4000 years ago, the level of Mono Lake rose to between elevation 6460 and 6499. The main evidence for this "Holocene highstand" seems to be the biogenic ooze found below the 2000 (?) BP ash penetrated in the 10 meter core hole at the Mono County Marina. He suggests that the lake level fell to below elevation 6400 by the time of the 2000 BP Mono Craters tephra, and a further drop to 6365 between 1900 and 1800 years ago. The 6365 level may represent the cutting of the "25-foot terrace" mentioned by Scholl and others (1967) when the lake was at elevation 6392. From about 2000 BP to less than 900 BP, Stine shows that the lake level remained below elevation 6390. About 900 years ago there was an abrupt rise to about elevation 6430, which was documented by radiocarbon dates on dead Jeffrey pines rooted between elevations 6370 and 6406. Another group of Jeffrey pines rooted between elevations 6385 and 6400 was killed by a later rise in lake level between 700 and 600 years ago. The lake elevation at the time of the eruption of the 600 BP ash is stated to be 6406, based upon indications that the ash fell upon two different surfaces. The surface above 6406 was vegetated and windblown; below 6406 was a littoral environment. The lake level rise postulated for 400 years BP is not confirmed by a radiocarbon date, but is related to a soil zone associated with a lake regression at about that time. One of the most significant findings of Stine is that Paoha Island was not uplifted until sometime between 1720 A.D. and the arrival of the first settlers about 1850 A.D. The main evidence for such a conclusion is that Paoha Island does not show an erosional shoreline at elevation 6456, which has been documented by three radiocarbon dates as having occurred about 220 years ago. Such a wave-cut notch is prominent on Negit Island, which is older that Paoha Island. The same elevation 6456 shoreline has been eroded into the block avalanche deposit resulting from the 600 BP eruption of Panum Crater. Stine considers the 6456 highstand to be the highest level of the last 2000 years. The last peak on Figure 28 represents the measured highstand in July 1919.

Fluctuations in Historic Time

The 1857 Lake Elevation. The elevation of Mono Lake in the 1855-57 period has been the subject of much controversy. The significance of this period stems from the fact that this was the time of the first important land survey in the Mono Basin. This survey was conducted by Colonel A. W. von Schmidt, under contract to the United States Land Office. One of his important contributions was the "meandering" of most of the shoreline of Mono Lake. His mission was the establishment of horizontal control, but not vertical control. The elevation of Mono Lake in the latter part of the 19th Century remained an intriguing problem for many decades. As will be discussed later, a bench mark was cut at the level of Mono lake in 1883 but this was submerged a few years later and remained submerged for more than 60 years. In the early 1930's, accurate surveys were required for the all-gravity Mono Basin Project, including the Mono Craters Tunnel. On May 12, 1934, S. L. Parratt of LADWP attempted to resolve the problem of the 1855-57 lake elevations using the original survey notes of von Schmidt. The lake elevation on that date was 6416.22 on the datum used by LADWP. Parratt located the west quarter corner of Section 7, T1N, R28E -- a 2-inch iron pipe. He extended the range line 700 feet to the north and set a stake, over which a transit was set up. He then calculated where the northwest corner of Section 7 should be (at that date under water). From the von Schmidt survey notes, which had located the edge of the lake in a direction N 45° W from the northwest corner of Section 7, and at a distance of 1.50 chains (99 feet), he then calculated that this point on the edge of the 1856 lake would be found in a direction N45° 47.5'W at a distance of 693 feet from the stake over which the transit was set. Using a boat and a stadia rod, he located this point and sounded the depth of the water, which was 9.6 feet. Parratt's survey determined the 1856 level of the lake to be 6406.6 feet. Despite this careful survey, speculation as to the 1855-57 lake elevation continued (Harding, 1935; Lynch, 1948). Harding and Lynch, using dubious procedures, arrived at an 1856 lake elevation of 6376.

This problem has been reviewed in depth by Stine (1981). From a study of old maps, more recent USGS quadrangles, and early climatic information before and after 1857, Stine concluded that the 1857 elevation of Mono Lake was 6407(+/-1) feet, which was essentially the same as had been determined by Parratt in 1934.

For the present report, copies of von Schmidt's original notes were obtained from the Bureau of Land Management in Sacramento in order to make an independent evaluation of this problem. From these notes, the positions of the edge of the lake in 1856 were plotted on the four USGS quadrangles which include portions of Mono Lake. These are as follows:

Name	Date	Lake Elevation and Date
Bodie	1958	6402 - November 1958
Trench Canyon	1958	6402 - November 1958
Cowtrack Mountain	1962	6395 - May 1962
Mono Craters	1953	6409 - 1953

On the Trench Canyon Quadrangle, on 10 points plotted (nos. 13 to 22 on Figure 27), six points show positions above the lake elevation of 6402, and four plot on the lake edge. On the Cowtrack Mountain Quadrangle, all eight points plotted (nos. 23-30) were more than 1000 feet from the shoreline when the lake was at elevation 6395. On the Mono Craters Quadrangle, which shows a lake elevation of 6409, five points plot at the water's edge (nos. 31,32, 34 - 36) and two (nos. 33 and 37) plot in the water. On the Bodie Quadrangle, with a lake elevation of 6402, of the twelve points plotted (nos. 1-12), eight are at elevations above 6402, one is in the water, and three are at the water's edge. The extension of the southern boundary of Section 19, T2N, R26E must be a mistake in von Schmidt's notes as it is inconsistent with the other points plotted in this study. From this review, it is apparent that the 1856 elevation of Mono Lake was between 6402 and 6409. The actual elevation was probably close to the 6406.6 determined by Parratt in his 1934 survey.

<u>The 1883 Lake Elevation</u>. Russell (1889, p. 269) states flatly that "Lake Mono is 6380 feet above the sea". To etch the lake level indelibly for posterity, W. D. Johnson (Russell's topographer) chiseled an inverted T on an outlying crag on the southwest shore of Negit Island and indicated the position with an "x" on the bathymetric map (Plate XIX). The following note appears on page 299:

> "This crag, at the time of making the record, November 5, 1883, was barely separated from Negit Island. Its highest point was then 7.9 feet above the lake surface. Its northern and southern borders were abrupt, and it is formed of the same kind of rock as the larger island. The bench mark consists of a ⊥ chiseled in the rock on its southern face. The horizontal line of the ⊥ is four inches long, and was cut at the water's edge; the line at right angles to it is 10 inches long and extends up the face of the rock."

There has been some speculation as to how the 6380 elevation was obtained. Some have suggested the use of an aneroid barometer. However, the Russell report on page 269 states:

> "the elevations of the following localities about Mono Valley were computed by W. D. Johnson from

> triangulations made by himself and connected Mt. Conness, the height of which was kindly furnished by the U. S. Coast & Geodetic Survey."

The controversy over the 1855-57 elevation of Mono Lake called into question Russell's elevation of 6380 for 1883. For Russell's figure to be correct, the lake level would have fallen from Parratt's figure of 6407 in 1856 to 6380 in 1883 -- a drop of 27 feet in only 27 years. The certain resolution could come only when the Russell bench mark was re-exposed; this did not occur until September 1950 (Plate 4). In the following summer (August 1951), R. V. Phillips made a careful survey to the Russell bench mark and established the elevation as 6410.05 feet, about 30 feet higher than the elevation given by Russell.

Area-Capacity Tables. For the *Aitken* case in 1934, an area-capacity table for Mono Lake was developed by Los Angeles. Lake bottom contouring by Russell (Plate XIX) was used as a base for this area-capacity table. Suspecting that Russell's lake elevation was only an approximation, and not having access to the submerged bench mark cut by Russell, E. A. Bayley of the LADWP, after studying all of the evidence available to him, concluded that the Mono Lake surface elevation of January 1934 was 2.5 feet higher than that of the summer of 1883. Using the LADWP datum, he estimated the 1883 elevation of Mono Lake to be 6412.5 feet above sea level. From this assumed lake elevation, the area-capacity curve was constructed from Russell's bathymetric map. Bayley's 7-page report, No. 1270 dated February 1934, has a detailed explanation of his investigation.

The Phillips' survey of 1951 found that the elevation of the re-exposed bench mark was 6410. The area-capacity curve was then adjusted for the 2.5-foot difference between the Bayley estimate and the elevation determined by Phillips.

A bathymetric survey of Mono Lake was run in July 1964 by Scholl and others (1967). Vorster (1985) has prepared an area-capacity curve from this survey.

LADWP continued to use the Russell bathymetry with the corrected 1883 lake elevation until 1986. In the summer of 1986, a new, detailed bathymetric survey was run by Pelagos Corporation of San Diego (Pelagos Corp., 1986) and a new area-capacity table and curve were prepared (Appendix D and Figure 31, respectively). All lake areas and storage calculations in the present report are with reference to the new area-capacity table.

The LADWP Mono Lake Datum. The vertical datum in the Mono Basin, a subject of great complexity, has been analyzed by McGhie (1986). The first organization to run levels in the Mono Basin was the U.S. Geological Survey, starting in 1898. Several individuals carried levels into the Mono Basin at various times, resulting in adjustments, and re-adjustments of previous leveling. All of the elevations in USGS Bulletins 342, 481, and 766 are before the "Sea Level Datum of 1929". Since 1929, attempts have been made to adjust to the "Sea Level Datum of 1929". Their efforts have been complicated by attempts to determine the differential uplift in the Long Valley Caldera during the 1980's. The USGS is still trying to tie together the level lines that went up the Owens Valley with those at Sonora.

The National Geodetic Survey (NGS), formerly called the U.S. Coast and Geodetic Survey, has primary jurisdiction over vertical (elevation) controls in the United States. All of their activities in the Mono Basin came after the "Sea Level Datum of 1929". Their leveling activities have been a continuing process. Elevations derived from the latest leveling are based on preliminary adjustments of previous leveling. These adjustments have been misunderstood and have been used (erroneously) to determine movements or settlements by comparing differences in elevations at different dates.

Before 1930, LADWP used elevations published in USGS Bulletin 766 for three bench marks near Mono Lake. LADWP found a discrepancy in elevation of one of these bench marks of 10.2 feet.

In December 1930, LADWP ran levels to a bolthead in the top of a concrete slab at the Mono Lake Cooperative Gaging Station of the USGS and the Southern Sierras Power Company. This bolthead is shown on Plate 5. The elevation was determined to be 6426.790 based upon levels run by LADWP to bench mark 7723 on Deadman Hill, whose elevation was published in USGS Bulletin 766. This bolthead reference point and elevation has been used by LADWP to set <u>all</u> staff gages at Mono Lake and in the lagoons from 1930 to the present.

Both the USGS and USC&GS adjusted their values to conform to the "Sea Level Datum of 1929". The amount of this adjustment not only differs from bench to bench, but also differs between government agencies. LADWP has never made an adjustment to its bolthead elevation. This explains why many Mono Lake elevations published in USGS water supply papers are 0.37 foot higher than those reported by LADWP. Since 1976, the USGS has been publishing the unadjusted LADWP figures. To tie the bolthead into the latest NGS published values, McGhie, on April 1, 1986 ran a level line from the bolthead to NGS Bench Mark U916 at Tioga Lodge. This survey showed that the bolthead datum was 0.37 foot higher than the 1975 NGS adjusted datum. USGS Water Supply Paper 765 would indicate the bolthead datum is 0.37 foot lower than the USGS datum. If the bolthead datum were to be adjusted, there is not only the problem of how much to adjust it, but the problem of which direction.

For hydrological purposes, the problem of the exact elevation above sea level of Mono Lake is not important. Much more critical are changes of elevation; which have been adequately determined for more than 56 years by staff gages referenced to the same bolthead. McGhie has recommended that the LADWP measurements be published as MONO LAKE DATUM, and that the bolthead bench mark be continually tied to the most current sea level datum. By means of a footnote, the MONO LAKE DATUM could be shown as "x" feet above or below the current supplementary adjustment.

Systematic measurements of the levels of Mono Lake were started in 1912. Prior to that year, there were few reliable measurements; exceptions are for 1857 (6407±1) and 1883 (6410). The USGS measurements for 1898 and 1909 are considered fairly reliable. The Forest Service furnished gage heights for Mono Lake for the period from 1912-34. Unfortunately, the datum for such measurements is unknown. LADWP began to measure lake levels on December 28, 1925, before the establishment of the bolthead in December 1930. The datum for these earlier years is not positively known. The water surface elevations for Mono Lake for 1912-86 are given in Appendix E. The elevations are all on the MONO LAKE DATUM, with somewhat less certainty prior to December 1930. Elevations given in Todd (1984) are consistently 0.37 foot higher; they incorporate the adjustment to the "Sea Level Datum of 1929" but no other adjustment.

VIII. HYDROLOGIC BALANCES

Base Period

In any hydrologic study, it is desirable to work with a base period during which precipitation and runoff within the study area approximate the long-term water supply conditions. There should also be available sufficient additional hydrologic information to permit an evaluation of the amount, distribution, and disposal of the normal water supply under the most recent land use conditions. A desirable base period includes both wet and dry periods similar in magnitude and occurrence to the normal supply.

A study was made (for the former 1941-76 base period) of cumulative departures from the long-term mean for both precipitation and runoff. Precipitation stations used were Cain Ranch (Table 7 and Fig. 16) and Gem Lake (Table 8 and Fig. 17). The runoff was analyzed for Lee Vining Creek (Table 3, Col. 1, and Fig. 20), Mill Creek (Table 3, Col. 10, and Fig. 21), and for the total measured runoff (Table 3, Col. 11, and Fig. 22). The following tabulation indicates that water supplies during the former 1941-76 base period were reasonably close to long-term conditions, and are even closer for the new 1941-85 base period.

		Period 1941-76		Period 1941-85	
Stations	Long-Term Avg. of Record	Per. Avg.	% of Long-Term	Per. Avg.	% of Long-Term
Precipitation (inches)					
Gem Lake (1925-85)	21.81	20.02	91.8	20.91	95.9
Cain Ranch (1931-85)	11.44	10.88	94.4	11.34	99.1

(Continued)

Stations	Long-Term Avg. of Record	Period 1941-76 Per. Avg.	Period 1941-76 % of Long-Term	Period 1941-85 Per. Avg.	Period 1941-85 % of Long-Term
Runoff (cfs)					
Lee Vining Creek (1935-85)	68.2	64.4	94.4	66.6	97.7
Mill Creek (1935-85)	30.3	28.8	95.0	30.1	99.3
Total Measured Runoff (1935-85)	206.4	195.9	94.9	204.2	98.9

It should be noted that a lack of adequate hydrologic data precluded any period starting before 1935. Furthermore, it was deemed important to concentrate on items of supply and disposal only after the commencement of exports in 1940-41.

The earlier base period (1941-76) was superseded by the more up-to-date period 1941-85. Certain hydrologic parameters have not been changed, such as the ungaged runoff in Tables 5A and 5B, and the cumulative departure curves in Figures 16, 17, 20, and 21.

Precipitation

Precipitation data for the base period were obtained from the stations listed in Table 2; their locations are shown on Figure 14. Although only three of the precipitation stations have complete records for the entire base period, the isohyetal map (Fig. 15) was constructed using shorter periods from nine precipitation stations and four snow courses in the Mono Basin area. Average annual precipitation for individual drainages is given in Tables 5A and 5B. The 1941-76 precipitation in the Mono Basin is summarized as follows:

Item	Area (1)	Area Sq. Mi. (2)	Total Precipitation (36-Yr. Avg. 1941-76) In/Yr (3)	AF/Yr (4)	CFS (5)
1.	Hill and Mtns.	364	15.7	303,700	419
2.	Valley Fill Area*	304	9.6	156,000	216
3.	Mono Lake**	80	8.0	34,000	47
4.	Total watershed	748	12.4	493,700	682

Hill and Mountain Runoff

Most of the runoff in the Mono Basin occurs in the major streams originating in the Sierra Nevada. These flows have been measured at 9 gaging stations (Table 3); except for earlier measurements on Mill Creek, no systematic measurements were started until 1934. The average measured runoff for the 1941-85 base period was 147,972 (204.2 cfs). Although these gaging stations control only 35 percent of the hill and mountain area in the Mono Basin, the measured flows constitute about 85 percent of total runoff from the hill and mountain watersheds. Runoff from individual ungaged watersheds was estimated (page V-3) and the

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(*) - Excluding Mono Lake

(**) - Average Area during 1941-76 (50,900 acres).

area. Average annual precipitation for individual drainages is given in Tables 5A and 5B. The 1941-76 precipitation in the Mono Basin is summarized as follows:

			Total Precipitation (36-Yr. Avg. 1941-76)		
Item	Area (1)	Area Sq. Mi. (2)	In/Yr (3)	AF/Yr (4)	CFS (5)
1.	Hill and Mtns.	364	15.7	303,700	419
2.	Valley Fill Area*	304	9.6	156,000	216
3.	Mono Lake**	80	8.0	34,000	47
4.	Total watershed	748	12.4	493,700	682

Hill and Mountain Runoff

Most of the runoff in the Mono Basin occurs in the major streams originating in the Sierra Nevada. These flows have been measured at 9 gaging stations (Table 3); except for earlier measurements on Mill Creek, no systematic measurements were started until 1934. The average measured runoff for the 1941-85 base period was 147,972 (204.2 cfs). Although these gaging stations control only 35 percent of the hill and mountain area in the Mono Basin, the measured flows constitute about 85 percent of total runoff from the hill and mountain watersheds. Runoff from individual ungaged watersheds was estimated (page V-3) and the

---

(*) - Excluding Mono Lake

(**) - Average Area during 1941-76 (50,900 acres).

results of these calculations are shown in Tables 5A and 5B. From the ungaged tributary areas (about 149,000 acres) estimated 1941-76 runoff was 25,000 AF/yr (34 cfs).

Imported/Exported Water

Imports and exports have been discussed earlier (Section V). Water has been imported into the northern portion of the Mono Basin from the East Walker drainage area for many years. Diversions from Virginia Creek in the amount of 2,500 to 3,000 acre-feet per year are used for irrigation on the Conway Ranch.

Export of water from the Mono Basin by Los Angeles began during the water year 1940-41. Through 1984-85, these exports have averaged 68,100 acre-feet per year. From 1969-70 to 1984-85, the exports have average 90,100 acre-feet per year. The Los Angeles water facilities in the Mono Basin are shown on Figure 4. After leaving the Mono Craters Conduit, the exports (Table 6) enter the Mono Craters Tunnel at the West Portal. This 11-mile tunnel was driven through fractured volcanic rocks and functions as a drain. The inflowing ground water (tunnel make) averages 12,000 AF/yr. About 40 percent of the tunnel length underlies the Mono Basin watershed and the remainder underlies the Long Valley Basin watershed. It is assumed that 40 percent of the tunnel make is ground water that would otherwise be tributary to Mono Lake. From the standpoint of the overall Mono Basin hydrologic balance, the export would thus be the flow to the West Portal plus 40 percent of the tunnel make.

Lake Evaporation

Mono Lake is the ultimate sink for all water which reaches it, whether from direct rainfall, stream flow, or ground water inflow. All of this water is disposed of by evaporation. During the 1941-85 base period, evaporation from Mono Lake averaged 161,200 AF/yr. Because this is the only item of outflow from Mono Lake, it has been the subject of great interest and research.

Numerous studies have been made of the rate of evaporation from Mono Lake. The earliest were those of Charles Lee during the period 1925-35 in conjunction with the *Aitken* case. Later studies were undertaken by Black (1958), Harding (1965), California Department of Water Resources (1960), Mason (1960), and Keenan Lee (1969). In addition to the early studies of Charles Lee, which were undertaken for the City of Los Angeles (LADWP), the LADWP has measured evaporation at Grant Lake (fresh water) using both floating and land pans (period 1941 to present), and at Mono Lake using a floating pan (period 1949-59). It was established in Charles Lee's studies that the rate of evaporation of Mono Lake decreases as both the specific gravity and salinity of the lake brine increases. Total evaporation is expected to decrease in the future as lake levels are lowered and as the surface area of the lake is reduced.

From these studies, the annual rate of evaporation for fresh water at Mono Lake is taken as 3.5 feet (42 inches). During the 1941-85 base period, the specific gravity of Mono Lake water increased from 1.039 to as high as 1.073. The average annual evaporation rate used in the historic model was 40 inches.

The very close correlation between historic lake levels and model-generated lake levels (Fig. 25) confirms that the 40-inch evaporation was close to actual.

Change in Storage

The key element in any hydrologic balance in the Mono Basin is the change in storage of Mono Lake, according to the equation:

INFLOWS - OUTFLOWS = +/- CHANGE IN STORAGE

The calculation of volumetric change in storage of Mono Lake is based upon developing a relationship among (1) elevation of the lake surface; (2) area of the lake surface; and (3) volume of stored water. Such a relationship is commonly called an area-capacity table. Originally, such a table was developed from the bathymetric chart prepared by Russell (1889, Plate XIX). An updated version of the area-capacity table is based upon a new bathymetric survey which was conducted during August and September 1986 by Pelagos Corporation of San Diego, California (Appendix D). Technical guidance was provided by the United States Geological Survey and LADWP. The area-capacity data were derived from a 600,000-point matrix generated from bathymetric and photogrammetric measurements. Water depths were determined every 50 meters (164 feet) by precision echo sounders, and contour maps of the lake bottom were prepared with scales as large as 1:6000 and contour intervals as small as 2 feet. The new area-capacity table has been incorporated into LADWP's Mono Lake Hydrologic Model and in the future will be used to determine lake areas and stored water volumes at given elevations of Mono Lake.

Systematic measurements of the levels of Mono Lake have been made since 1912. During the 1941-85 base period and to the present time these measurements have been made weekly (Appendix E). Where necessary, they have been interpolated to the October 1 start of the hydrologic year. By using the lake levels in Appendix E, it is possible to determine the area and stored volume of Mono Lake at any time in the past and for any level in the future. In the model, calculations are geared to the areas and stored volumes as of the October 1 start of the hydrologic year. These levels, areas, and stored volumes as used in the model are given in Table 15. For the 1941-85 base period, the change in storage averaged (-) 42,500 AF/yr. For the 1970-85 period, the change in storage averaged (-) 30,700 AF/yr.

Surface/Subsurface Inflow

Essentially all of the surface and subsurface inflow to Mono Lake comes from the Sierra Nevada. About 85 per cent of the surface flow reaching the valley fill from the mountain watersheds is measured at nine gaging stations in or near the mountains and three or more miles from the shoreline of the lake. Some of the measured flows as well as some of the unmeasured flows percolate into the Holocene aquifer and reappear as spring flows before reaching the lake. Some of this percolating water travels even deeper into confined aquifers, becomes artesian, and exits as springs close to the lakeshore, or as springs beneath the surface of the lake. Other waters may enter fractures and reach the lake as spring flows without crossing any appreciable width of valley fill (Figure 12).

It is not possible to quantify, individually, the amounts of water which reach the lake via these various surface and subsurface routes. It is possible, however, to calculate the total amount of water which reaches the lake by these routes by the equation:

TOTAL INFLOW = LAKE EVAP - LAKE PPT +/- CHANGE IN STORAGE

All three items on the right side of the equation are determined independently, and the total inflow is calculated as a residual value. The annual amounts of surface and subsurface inflow to Mono Lake for the period 1934-35 through 1984-85 are given in Table 17. The average for the 1941-85 base period was 87,100 AF/yr.

Consumptive Use

Consumptive use is defined herein as the transformation of water from the liquid to the gaseous form by vegetation (evapotranspiration) or by evaporation from bare soil surfaces. Evaporation from Mono Lake is treated as a separate hydrologic item.

In the hill and mountain watersheds, rainfall my be disposed of by evapotranspiration in large areas of forests or scrub vegetation, by riparian vegetation along perennial streams, or by phreatophytes in mountain meadows and seep areas. Some of the rainfall may become recharge to groundwater in the highly fractured and jointed rocks which predominate in these watersheds.

Such water may follow shallow fracture paths and re-emerge as spring flow above the gaging stations -- thus sustaining the base flow of the major streams. Some of this groundwater may flow directly to Mono Lake; this condition is especially true in the ungaged watersheds between Lee Vining and Mono City (Figure 12).

No attempt has been made to study the unit (per acre) depths of consumptive use in the mountain watersheds, as the model does not require such a determination. In the gaged watersheds, total consumptive use by upstream vegetation can be calculated by the equation:

CONSUMPTIVE USE = RAINFALL - GAGED RUNOFF

Similarly, in the ungaged watersheds, the consumptive use is the calculated rainfall minus the estimated runoff. Consumptive use in many of the important watersheds can be calculated from the data presented in Tables 5A and 5B. For all the hill and mountain watersheds tributary to Mono Lake, the total rainfall averages 303,700 AF/yr and the total runoff averages 166,300 AF/yr. With an additional outflow allowance of 5000 AF/yr to the Mono Craters Tunnel, the total consumptive use in the hill and mountain watersheds averages about 132,400 AF/yr. If this is spread over the 232,900 acres in the hill and mountain watersheds, the unit depth of consumptive use is about 0.57 foot per year.

Unlike the relatively stable pattern of vegetative use in the hill and mountain watersheds, the patterns of vegetative use on the valley fill have been constantly changing since Mono Lake was at its recent historic high in 1919. On the valley fill, there are large areas of xerophytic vegetation which are able to survive on rainfall only. Other areas are (or have been) irrigated with diversions from perennial streams. As the lake levels have fallen, there have been many changes in the patterns of grasses sustained by high water tables in the Holocene aquifer. Some relicted areas have become vegetated with grasses. The sources of water to these grasses is rainfall (especially on sandy areas), percolation of streams flowing across the valley fill, or by artesian water moving upward from confined aquifers.

Hydrologic Balances

The historic balance for the 1941-85 base period has been calculated and is shown in Table 16. This balance is for the lowland areas only -- including the valley fill and Mono Lake.

Using criteria developed in the historic balance, and the Mono Lake Hydrologic Model, the projected water balance for Mono Lake itself was calculated assuming export by Los Angeles of 100,000 acre-feet per year and the stabilization of the level of Mono Lake at Elevation 6335. This balance appears in Table 19.

IX. MONO LAKE HYDROLOGIC MODEL

Introduction

Historical fluctuations of the levels of Mono Lake were discussed previously in Chapter VII. They show a natural pattern of changes related to wet and dry periods. Except for 1857 and 1883, only general indications are known from the early 1850's to the start of systematic measurements in 1912. From 1912 until the summer of 1919, there was a rise of 4.3 feet despite a large amount of irrigation in the Mono Basin. With the onset of dry conditions and the continuation of the local in-basin irrigation, there was a lowering of lake level of about 10.8 feet between 1919 and 1941, when export by City of Los Angeles started. These changes of lake levels are shown on Figures 26 and in Appendix E.

Commencing in April of 1941 and up to the present (1987), Los Angeles has diverted water for export and has supplied water for in-basin uses. The post-1941 activities have caused lake levels to drop at a greater rate than would have occurred under conditions which prevailed prior to 1941. During the period from April 1941 to October 1970, when Los Angeles was exporting an average of 57,000 acre-feet per year, the lake level dropped about 29 feet. From October 1, 1970 to October 1, 1985, when Los Angeles was exporting an average of 90,100 acre-feet per year, the lake level dropped an additional 7.5 feet.

Model of Historic Lake Level Fluctuations

To assist in the prediction of the water level elevations of Mono Lake in the future, Los Angeles has developed a model based upon the historic water balance. One of the key elements of the water balance is measured surface water inflow, for which records are available starting in about 1935. The earlier years incorporate the effects of activities which were in place prior to the start of exports in 1941. The surface runoff is measured at gaging stations which are several miles from the actual points at which the flows enter the lake. En route to the lake some of these measured surface flows are consumed by evapotranspiration, and large, but unknown, volumes are able to percolate to the underlying unconfined and confined aquifers. The actual inflow to the lake thus consists of direct surface flows in the creek channels and groundwater which follows much slower paths in the shallow and deeper confined aquifers. It is not possible to calculate the amounts of surface flows and groundwater flows separately -- they must be calculated together. To accomplish this, a relationship has been developed which compares that portion of measured surface flows which are undiverted, with inflows to the lake calculated from precipitation, evaporation, and change in storage. The undiverted surface flows are called "Measured Runoff towards Mono Lake" and are shown as annual values in Table 18. Note that the measured flows of Mill Creek (which can not be diverted for export) are not included in Table 18. The annual amounts of water which reached the lake are calculated in Table 17, and are called "Surface and Subsurface

Inflow to Lake". Annual pairs of values of these two parameters are plotted on Figure 23, which shows the least squares regression line and the equation of that line.

It is believed that the Mono Lake Hydrologic Model represents a reasonable predictive tool. However, an important objective is to keep it flexible so that new data can be incorporated into it easily. In this way its accuracy can be increased and its effectiveness as a predictive tool can be improved continually. For example, the 1986 model has been modified to accommodate variable inputs. More specifically, the modifications include:

1. The capability of projecting historic water supply variability for the entire 1941-85 base period or for portions of that base period.
2. The capability of projecting artificial periods of unusual wetness or unusual dryness through the assumption of annual indices for any hydrologic parameter for which there are annual indices.
3. The capability of using chosen time periods of specified annual exports.
4. The capability of predicting the future salinity of the lake as parts per million Total Dissolved Solids under any assumed future volume.

With these additional capabilities, the model can now generate the climatically dependent high and low levels of the lake at stabilization, rather than a single average level.

Model Development

The model was updated to include data available for a 1941-85 base period to solve the equation:

INFLOW - OUTFLOW = ± CHANGE IN STORAGE

It was tailored (verified) to represent hydrologic conditions as they actually existed in Mono Basin from 1940-41 through 1984-85. Annual data on lake levels are given for October 1 -- either measured on that date or interpolated from weekly measurements. Starting conditions for the model were assumed to be those existing as of October 1940. In-basin consumptive uses and the amounts of Mono Craters tunnel inflow from Mono Basins sources were assumed to be constant for the base period. These assumed conditions are incorporated into the projections as an annual average.

The base period 1940-41 to 1984-85 represents conditions close to those of normal water supply for the Mono Basin -- with averages within 1 to 4 per cent below those of the long term.

The tailoring procedures involved comparing the model-calculated lake elevations (Column 3, Appendix F, Page F-1) with the historic measured elevations (Column 2) for each year of operation for the period 1940-41 to 1984-85. In the 1986 model, the earlier base period of 1941-76 was replaced by a more up-to-date base period of 1941-85.

In the projection of average conditions to predict the level of stabilization, the curve becomes so flat as to make the year of stabilization difficult to predict. This fact, combined with the rounding of the stabilization level to the nearest foot, makes the predicted year of stabilization only an approximation.

The computer print-out of the base period verification run (as adjusted) is shown in Appendix F, page F-1. Column explanations are as follows:

> Water Year - Col. (1). The water year used is from October 1 to September 30.
>
> Measured Elevation - Col. (2). The lake level as measured on October 1, or as interpolated from weekly measurements.
>
> Calculated Elevation - Col. (3). Lake levels determined from the 1986 area-capacity table using the change in storage calculated by the model from the inflow-outflow equation.
>
> Model Difference - Col. (4). The difference between Col. (2) and Col. (3). For any water year it is the vertical difference between the two curves plotted on Figure 25.
>
> Calculated Volume - Col. (5). Volume of water stored in Mono Lake as of October 1 (acre-feet). Equal to the volume as of the previous October 1 adjusted upward or downward for the change in storage in the intervening water year (Col. 16).

Calculated Surface Area - Col. (6). The surface area determined by the model from the 1986 area-capacity table (to the nearest 10 acres) using the calculated volume in Col. 5.

Lake Precipitation Index - Col (7). The annual index of precipitation at the Cain Ranch station (Table 7, Col. 2). It is assumed that lake precipitation has the same pattern as Cain Ranch. Mean precipitation is taken as 11.34 inches (for 1941-85). In all predictions, except those in which the indices were intentionally fixed otherwise, an index value of 1.00 (normal) was assumed.

Annual Lake Precipitation - Col. (8). The long-term lake precipitation of 8.0 inches (0.67 foot) was determined from the isohyetal map (Figure 15).

Col. 8 = (Col. 6) x (Col. 7) x (0.67) = acre-feet/yr.

Runoff Index - Col. (9). The total measured runoff of Lee Vining, Walker, Parker, Rush, and Mill Creeks averages 147,972 acre-feet per year for the 1941-85 base period (Table 3). This does not include estimated flows from ungaged areas. The index is obtained by dividing the annual measured runoff (Col. 11, Table 3) by 147,792. In projecting future lake levels, except where the index was fixed otherwise, an index of 1.00 (normal) was assumed.

Flow to West Portal - Col. (10). The annual export from the Mono Basin at the upstream end of the Mono Craters Tunnel (West Portal). Measured as the outflow from Grant Lake minus the Mono Gate #1 releases, as shown in Col. 4 of Table 6. Such releases flow down lower Rush Creek toward Mono Lake.

Calculated Inflow - Col. (11). The annual combined value of surface and subsurface inflow derived from Figure 23, which is a plot of measured runoff toward the lake (Table 18) vs. inflow to the lake calculated from the hydrologic balance (Table 17). The calculation starts with the least squares regression line which is represented by the straight-line equation:

CALC. INFLOW = 0.97 (MEASURED RUNOFF - EXPORT) + 29,800

To arrive at a best fit correlation between model-generated lake levels and historic lake levels, the average annual measured runoff was adjusted downward from 126,100 to 124,500 AF/yr.

The steps in the calculation are as follows:

1. Take 1941-85 adjusted average measured runoff of 124,500. Note that this excludes flows of Mill Creek which can not be exported;
2. Multiply by 0.97 (the slope of the regression line);
3. Add 29,800 (the regression line intercept);
4. Multiply by the annual runoff index (Col.9);
5. Subtract 0.97 times Flow to West Portal (Col. 10).

Lake Evaporation Index - Col. (12). This index is derived from the four-month (June - September) evaporation from Grant Lake (Table 9). For the 1941-85 base period, the average four-month evaporation was 26.0 inches. The total annual evaporation of Mono Lake is assumed to be proportional to the four-month evaporation at Grant Lake.

Specific Gravity - Col. (13). The values in this column are derived from actual determinations of the specific gravity of Mono Lake water in various years. From an empirically derived relationship, the specific gravity is adjusted to the volume of water stored in the historic water year using the following equation:

$$SG = \frac{\text{Col. (5)} \times 1359 + 230 \times 10^6}{\text{Col. (5)} \times 1359}$$

One acre-foot of fresh water weighs 1359 tons.

Specific Gravity Adjustment - Col. (14). The evaporation adjustment as related to specific gravity was developed by Charles Lee in the early 1930's, and adopted by Loeffler in the Winkler report (1977). The applicable equations are:

(a) If S.G. is less than 1.121,

$$\text{Evap. Adj.} = -0.744 \text{ (Col. 13)} + 1.744$$

(b) If S.G. is equal to or greater than 1.121,

$$\text{Evap. Adj.} = -0.968 \text{ (Col. 13)} + 1.995$$

Annual Evaporation - Col. (15). Total evaporation from Mono Lake for each year was determined as:

Average annual fresh water evaporation (3.5 feet)* times annual evaporation index (Col. 12) times specific gravity adjustment (Col. 14) times calculated lake surface area (Col. 6).

(*) Based upon pan studies, the annual evaporation rate of a large fresh water body at Mono Lake would be 3.5 feet. Because of its salinity at the time of his studies in the early 1930's, Charles Lee found that Mono Lake evaporated at a rate only 96 per cent of that of fresh water. The close correlation of the model-generated lake levels with those measured historically indicates that the assumed relationships are correct, and that the average rate of evaporation of Mono Lake over the 1941-85 base period was close to 40 inches.

Change in Storage - Col. (16). The annual change in storage is derived by:

Annual lake precipitation (Col. 8) +
Annual model-calculated inflow (Col. 11) -
Annual evaporation (Col. 15)

Total Dissolved Solids - Col. (17). TDS is expressed in ppm (parts per million). The amount of salts dissolved in Mono Lake is assumed to remain constant at 285 million tons. This tonnage is derived as the average of the ten analyses shown on Table 14. In the model, the TDS is calculated as:

$$\frac{285 \text{ X } 10^6 \text{ TONS OF SALTS}}{\text{LAKE VOLUME X SPECIFIC GRAVITY X 1359}}$$

where 1359 = weight of one ton of fresh water

Hypothetical Future Lake Level Fluctuations

The prediction of future Mono Lake levels has been studied for more than 50 years. The earliest were those of Charles H. Lee in the early 1930's in conjunction with the condemnation of the littoral lands. Later studies in the 1970's, including the first use of a model, were those of Loeffler, during the preparation of the Winkler report (1977).

Assumptions

The prediction of future Mono Lake levels under various operational assumptions has been made by the use of the Mono Lake Hydrologic Model. For future diversions, the conditions of the 1941-85 base period have been used. Because Mill Creek can not be diverted for export, the measured flows of Mill Creek are not used in the relationship of measured runoff to lake inflow shown on Figure 23. This relationship is considered to be most reliable where the basic trend of lake levels is downward. When lake levels rise, as occurred in the early 1980's, there is potential for a hysteresis effect as some of the lake water moves into bank storage in the Holocene alluvium. Because of this effect, the area-capacity table may be slightly different on the rising cycle than on the falling cycle.

The relationship in Figure 23 incorporates the concept that practically all of the water which is released down Rush Creek or down Lee Vining Creek reaches Mono Lake. The only consumptive use of this water is by riparian vegetation or by phreatophytes in high water table areas. A large part of this water, especially at low flows, may percolate in the stream beds and become groundwater. Such groundwater, although it travels a much slower path, inevitably reaches Mono Lake.

The curve of future stabilization levels at various diversion rates is shown on Figure 24. The general assumptions made for the stabilization runs of the model are as follows:

<u>Starting Lake Levels</u>. Various starting lake levels were used, mainly 1940 (start of exports) and the current level. The starting level for October 1, 1986 was elevation 6380.2.

<u>Storage and Change in Storage</u>. Calculations of the stored water and annual changes of storage as the lake rises or falls were based on the area-capacity table developed in the recent (1986) bathymetric survey.

<u>In Basin Uses</u>. The amount of water consumptively used within the basin, based on expected future irrigation-water use needs. These uses would be those reflected during the 1970-86 period.

<u>Indices</u>. The year-by-year indices for precipitation, evaporation, and surface/subsurface flow to the lake were assumed to be 1.00 (normal).

<u>Evaporation Rate</u>. The starting evaporation rate in 1985 was 3.3 feet. For future projections, the evaporation rate was multiplied by the area of the lake in each particular year in the projection.

Surface/Subsurface Inflow. The value was obtained from the equation:

INFLOW TO LAKE = 0.97 (124,500 - Exports) + 29,800 using adjusted historic runoff measurements and an adjusted form of the relationship developed in Figure 23. For any assumed amount of annual export, the figure remained constant for the entire period of the projection.

Lake Salinity. The total tonnage of dissolved salts was assumed to remain constant at 285 x 10^6 tons for all historic and future periods (Section VI). Some additional salts are carried into Mono Lake on a continuing basis by the tributary streams, but these contributions are considered insignificant. The lake salinity at stabilization was assumed to be lower than the concentration at which salts would be expected to precipitate.

Results

The results of two of the operational runs are summarized as follows:

Zero Export by Los Angeles - (1941 to 1985)

Theoretical lake level if there had been no export by Los Angeles from 1941 through 1985, and with all other assumptions remaining the same would be 6417.48 on October 1, 1985.

Future Stabilization Level of Mono Lake - Assuming Normal Export

Assume 100,000 AF/yr export. Stabilization level would be 6335 feet in the Year 2092-2093. The year-by-year values for all hydrologic parameters are shown in Appendix F. The projected change of lake levels is shown in Figure 26.

Tables

TABLE 1

GEOLOGICAL TIME SCALE

Era	Period	Epoch	Tentative Absolute age[a]
Cenozoic	Quaternary	Holocene	
			11,000 yr
		Pleistocene	
			2 m.y.
	Tertiary	Pliocene	
			12
		Miocene	
		Oligocene	
			37
		Eocene	
			53
		Paleocene	
			70
Mesozoic	Cretaceous		
			135
	Jurassic		
			190
	Triassic		
			230
Paleozoic	Permian		
			280
	Pennsylvanian		
	Mississippian		
			350
	Devonian		
			400
	Silurian		
			430
	Ordovician		
			500
	Cambrian		
			600
Precambrian			600-3600 m.y.
	- - - - Lost interval - - - -		
Origin of earth			4600 m.y.

[a] m.y. = million years

Source: Sharp (1972)

TABLE 2

MONO BASIN

Average Annual Precipitation

Period of Record, Former 36-Year Base Period, and 45-Year Base Period

Station (1)	Period of Record (2)	Location Latitude (3)	Location Longitude (4)	Elevation Feet (5)	Average Precipitation Period of Record (Inches) (6)	Average Precipitation Period of 1941-76 (Inches) (7)	Average Precipitation Period of 1941-85 (Inches) (8)
Bodie	1965-68	38° 13'	119° 01'	8370	19.2	-	-
Cain Ranch	1931-32 to 1984-85	37° 54'	119° 05'	6850	11.44	10.88	11.34
East Side Mono Lake	1975-76 to 1984-85	38° 5'	118° 59'	6840	5.70	-	-
Ellery Lake	1925-26 to 1984-85	37° 56'	119° 14'	9645	25.68	22.45	20.42
Gem Lake	1925-26 to 1984-85	37° 49'	119° 08'	8970	21.81	20.02	20.91
Mark Twain Camp	1950-55	38° 12'	118° 45'	7230	6.8		
Mono Lake	1951-68	38° 00'	119° 09'	6450	12.5	-	-
Rush Creek Power House	1957-79	37° 46'	119° 08'	7235	25.20	-	-

TABLE 3

Mono Basin
Measured Hill and Mountain Runoff
in Acre-Feet

Water Year	Lee Vining Cr. Sta. No. 1108 (1)	Walker Cr. Sta. No. 1339 (2)	Gibbs Cr. Sta. No. 1005 (3)	Gibbs Cr. Sta. No. 1005D (4)	Parker Cr. Sta. No. 1226 (5)	Parker Cr. Sta. No. 1228 (6)	Parker Cr. Sta. No. 1229 (7)	Rush Cr. Sta. No. 1252 (8)	Mono Basin Measured Runoff Subtotal (9)	Mill Cr. Sta. No. 399 (10)	Mono Basin Total Measured Runoff (11)	% of Mean (12)
1934-35	50,535	3,709	883	1,251	8,281	263	936	59,113	124,971	16,706	141,677	95
-36	57,048	4,682	805	1,125	7,686	98	409	67,453	139,306	24,264	163,570	109
-37	51,895	4,909	871	1,143	7,760	224	612	56,732	124,146	23,340	147,486	99
-38	82,034	8,614	1,687	1,401	10,919	365	1,582	99,562	206,164	36,008	242,172	162
-39	43,665	4,279	861	1,015	7,261	172	759	45,568	103,580	16,294	119,874	80
1939-40	62,160	5,053	1,083	1,204	8,038	105	478	53,168	131,289	22,554	153,843	103
-41	65,873	7,480	1,167	1,399	9,465	206	1,034	79,538	166,162	28,255	194,417	130
-42	65,774	6,943	1,195	1,420	9,881	408	1,362	76,679	163,662	27,279	190,941	128
-43	76,328	6,578	1,025	1,348	8,918	302	1,186	64,569	160,254	28,070	188,324	126
-44	46,933	4,357	744	992	7,169	187	820	47,716	108,918	18,319	127,237	85
1944-45	51,383	6,088	1,010	1,367	9,100	350	1,084	73,610	143,992	26,311	170,303	114
-46	52,505	5,210	907	1,308	8,629	361	1,184	62,868	132,972	21,873	154,845	104
-47	34,123	4,058	870	892	6,848	239	737	45,890	93,657	17,890	111,547	75
-48	37,794	3,630	861	696	6,272	73	411	46,494	96,231	16,245	112,476	75
-49	30,738	3,675	306	808	6,594	221	496	53,981	96,819	15,630	112,449	75
1949-50	37,318	3,155	422	488	5,751	72	443	49,141	96,790	18,052	114,842	77
-51	53,168	6,117	2,391	1,158	7,827	262	650	48,031	119,604	26,010	145,614	97
-52	66,282	6,941	1,668	1,423	9,978	335	1,310	83,783	171,720	30,270	201,990	135
-53	43,789	4,530	433	874	6,786	187	853	52,433	109,885	19,220	129,105	86
-54	25,155	3,506	492	421	5,598	108	421	38,993	74,694	15,639	90,333	60
1954-55	29,081	3,345	1,082	621	6,080	137	545	44,748	85,639	14,776	100,415	67
-56	56,377	7,663	1,360	1,420	9,872	625	1,374	83,826	162,517	31,503	194,020	130
-57	45,318	4,791	990	1,050	7,391	177	937	56,786	117,440	19,327	136,767	91
-58	50,790	6,974	1,422	1,198	10,428	478	1,238	70,362	142,890	26,860	169,750	114
-59	33,918	2,853	453	850	6,586	119	715	41,874	87,368	14,177	101,545	68
1959-60	27,982	2,534	1,019	221	5,252	53	309	31,362	68,732	13,719	82,451	55
-61	27,074	2,939	1,139	244	5,929	62	243	30,839	68,469	12,416	80,885	54
-62	45,437	6,386	808	951	8,123	291	524	63,340	124,860	20,667	145,527	97
-63	48,293	6,438	715	1,381	9,061	426	1,176	65,845	133,335	24,364	157,699	105
-64	32,297	3,370	491	847	6,238	82	695	42,790	86,810	13,581	100,391	67
1964-65	56,505	6,298	1,103	1,522	8,455	260	869	65,344	140,356	26,881	167,237	112
-66	38,575	3,453	650	1,093	6,911	189	973	58,449	110,293	14,215	124,508	83
-67	64,103	7,505	2,185	1,215	11,745	632	1,640	91,643	180,668	30,057	210,725	141
-68	36,989	3,732	511	1,008	6,738	209	792	50,270	100,249	13,996	114,245	76
-69	76,848	8,941	2,405	1,368	12,396	853	1,467	100,422	204,700	36,313	241,013	161

TABLE 3 (contd.)

Mono Basin
Measured Hill and Mountain Runoff
in Acre-Feet

Water Year	Lee Vining Cr. Sta. No. 1108 (1)	Walker Cr. Sta. No. 1339 (2)	Gibbs Cr. Sta. No. 1005 (3)	Gibbs Cr. Sta. No. 1005D (4)	Parker Cr. Sta. No. 1226 (5)	Parker Cr. Sta. No. 1228 (6)	Parker Cr. Sta. No. 1229 (7)	Rush Cr. Sta. No. 1252 (8)	Mono Basin Measured Runoff Subtotal (9)	Mill Cr. Sta. No. 399 (10)	Mono Basin Total Measured Runoff (11)	% of Mean (12)
1969-70	49,845	5,617	813	1,216	7,600	221	835	54,705	120,852	21,018	141,870	95
-71	47,601	4,650	816	1,019	7,363	213	712	49,026	111,400	20,113	131,513	89
-72	35,433	3,588	527	1,165	6,899	202	746	47,293	95,853	14,312	110,164	74
-73	51,245	6,662	1,089	1,159	9,192	267	924	63,089	133,627	21,382	155,009	104
-74	57,514	6,193	1,822	1,211	8,864	364	1,168	68,973	146,109	23,778	169,887	114
1974-75	50,998	5,859	1,386	1,074	8,670	424	1,137	57,975	127,523	19,945	147,468	99
-76	29,595	3,286	1,073	395	5,379	81	472	32,197	72,478	9,618	82,096	55
-77	21,661	3,032	417	1,215	5,144	19	204	24,358	56,050	8,593	64,643	43
-78	52,329	7,348	0*	2,089	10,294	342	1,035	83,234	156,671	27,078	183,749	123
-79	43,122	6,385	0*	1,764	8,593	371	1,427	68,136	129,788	22,400	152,188	102
1979-80	65,752	7,921	0*	2,249	11,134	727	1,615	81,928	171,326	31,380	202,706	136
-81	35,261	4,645	0*	2,306	6,924	206	1,140	50,804	101,286	16,690	117,976	79
-82	73,635	8,320	0*	2,091	10,671	425	1,530	86,306	182,978	35,299	218,277	146
-83	91,021	12,044	0*	1,893	14,771	772	2,626	121,013	244,140	42,034	286,174	191
-84	70,518	7,844	0*	2,235	10,239	355	1,424	77,735	170,350	29,156	199,506	133
1984-85	39,932	4,305	0*	1,737	6,133	203	763	53,216	106,289	17,623	123,912	83
1935-85 Total	2,519,549	272,435	43,957	61,540	417,826	14,323	48,022	3,123,210	6,505,862	1,121,500	7,627,362	
51-Year Mean	49,403	5,440	862	1,207	8,193	281	942	61,239	127,566	21,990	149,556	100
1941-85 Total	2,172,212	246,189	37,767	54,401	387,891	13,096	43,246	2,741,614	5,676,406	982,334	6,658,740	
45-Year Mean	48,271	5,471	839	1,209	8,620	291	961	60,925	126,142	21,830	147,972	99
1941-76 Total	1,678,981	184,345	37,350	36,822	283,988	9,676	31,482	2,094,884	4,357,528	752,081	5,109,609	
36-Year Mean	46,638	5,121	1,038	1,023	7,889	269	874	58,191	121,043	20,891	141,934	95
1970-85 Total	815,462	97,699	7,943	24,818	137,860	5,192	17,758	1,019,988	2,126,720	360,419	2,487,139	
16-Year Mean	50,966	6,106	496	1,551	8,616	325	1,110	63,749	132,920	22,526	155,446	104

(*) Note: Beginning in 1977-78 Gibbs Cr. Sta. No. 1005 is included in the measurement of Lee Vining Cr. Sta. No. 1108

TABLE 4

MONO BASIN

Average Annual Measured Runoff for Period of Record, Former 36-Yr. Base Period and 45-Yr. Base Period

Values in Acre-Feet and CFS

			Average Runoff		
Station	Period of Record (Water Years)	Location	Period of Record AF(CFS)	Period of 1941-76 AF(CFS)	Period of 1941-85 AF(CFS)
Lee Vining Cr. (#1108)	1934-35 to 1984-85	NE 1/4, Sec. 24, T1N, R25E, MDB&M.	49,400(68.2)	46,638(64.4)	48,271(66.6)
Walker Cr. (#1339)	1934-35 to 1984-85	SE 1/4, SE 1/4 Sec. 32, T1N R26E, MDB&M	5,440(7.5)	5,121(7.1)	5,471(7.5)
Gibbs Cr. (#1005)	1934-35 to 1984-85	SW 1/4, NE 1/4, Sec. 19, T1N R 26E, about 2-1/4 miles above range station.	862(1.2)	1,038(1.4)	
Gibbs Cr. (#1005D)	1934-35 to 1984-85		1,207(1.7)	1,023(1.4)	1,209(1.7)
Parker Cr. (#1226)	1934-35 to 1984-85	Sec. 19, T1S, R26E, MDB&M, near east quarter point of section.	8,193(11.3)	7,889(10.9)	8,620(11.9)
Parker Cr. (#1228)	1934-35 to 1984-85	SE 1/4 of NW 1/4, Sec. 16, T1S, R26E, MDB&M	281(0.4)	269(0.4)	291(0.4)
Parker Cr. (#1229)	1934-35 to 1984-85	SW 1/4 of NW 1/4, Sec. 16, T1S, R26E, MDB&M	942(1.3)	874(1.2)	961(1.3)
Rush Cr. (#1252)	1934-35 to 1984-85	NW 1/4 Sec. 9, T2S, R26E, MDB&M	61,239(84.5)	58,191(80.3)	60,925(84.1)
Mill Cr. (#1146)	1934-35 to 1984-85	T2N, R25E.	21,990(30.3)	20,891(28.8)	21,830(30.1)
DeChambeau (#1740)	1935-36 to 1977-78	SW 1/4, NE 1/4, Sec. 24, T2N R25E, MDB&M, just east of center line of section.	915(1.3)	826(1.1)	

TABLE 5A

MONO BASIN

Calculated Averge Annual Precipitation and Calculated Surface Runoff from Hill and Mountain Areas (Period 1940-41 to 1975-76)

Stream or Area (1)	Area Acres (2)	Calculated Avg. Precip.		Calculated Average Runoff		% of Total Runoff (7)
		In. (3)	Ac-Ft (4)	Ac-Ft (5)	CFS (6)	
I. Hill and Mountain Areas						
1. North Side of Basin	55,800	13.0	60,400	15,100	20.9	9.1
2. East Side of Basin	61,000	6.0	30,500	3,100	4.3	1.9
3. South Side and Misc. Interior Mountains	18,600	10.7	16,600	1,700	2.3	1.0
4. West Side of Basin	97,500	24.1	196,200	146,440	202.1	88.0
5. Total Hill and Mountains	232,900 (364 mi^2)	15.7	303,700	166,300	229.6	100.0
II. Valley Fill Area (Excl. Mono Lake)*	194,600 (304 mi^2)	9.6	156,000			
III. Mono Lake*	50,900 (80 mi^2)	8.0	34,000			
IV. Total Watershed (Precip. and Area)	478,800 (748 mi^2)	12.4	493,700			

* Avg. lake area for base period 1941-76, approximately 50,900 acres (see Table 15).

TABLE 5B

MONO BASIN

Calculated Averge Annual Precipitation and Surface Runoff from Hill and Mountain Areas (Period 1940-41 to 1975-76)

Stream or Area (1)	Area Acres (2)	Calculated Avg. Precip. (1941-76)		Measured and Calculated Runoff		% of Total Runoff (7)
		In. (3)	Ac-Ft (4)	Ac-Ft (5)	CFS (6)	
West Side of Basin						
A. Gaged Tributary Area*						
1. Rush Crk (#1252)	32,900	26.3	72,100	58,190	80.3	35.0
2. S. Parker (#1229)	1,300	17.8	1,900	870	1.2	0.5
3. E. Parker (#1228)	1,000	19.2	1,600	270	0.4	0.2
4. Parker (#1226)	4,700	23.0	9,000	7,890	10.9	4.7
5. Walker Crk (#1339)	5,000	22.5	9,400	5,120	7.1	3.1
6. Gibbs Crk (#1005)	1,900	21.1	3,300	1,040	1.4	0.6
7. Lee Vining Crk (#1108)	22,200	26.0	48,100	46,640	64.4	28.0
8. DeChambeau Crk (#926)	2,300	17.4	3,300	830	1.1	0.5
9. Mill Crk (#1146)	12,300	28.1	28,800	20,890	28.8	12.6
10. Subtotal West Side (Gaged Areas)	83,600	25.5	177,500	141,700	195.6	85.2
B. Ungaged Tributary Area**						
1. Misc. Grant Reservoir Area	1,500	17.1	2,100	500	0.7	0.3
2. Area Between Walker and Parker	600	18.5	900	300	0.4	0.2
3. Area Between Walker and Gibbs	400	24.0	800	200	0.3	0.1
4. South June Lake Area	2,000	15.5	2,600	600	0.8	0.4
5. Area Between Gibbs and Lee Vining	500	19.5	800	200	0.3	0.1
6. Area Between Lee Vining and Dechambeau	8,900	15.5	11,500	2,900	4.0	1.7
7. Subtotal West Side (Ungaged Areas)	13,900	16.1	18,700	4,700	6.5	2.8
C. Total (Gaged & Ungaged Areas)	97,500	24.1	196,200	146,400	202.1	88.0

(*) - Areas which have gaged runoff measurements (see Table 4).

(**) - Areas which are not gaged. Only calculated runoff figures are available.

TABLE 6 (cont.)

MONO BASIN

EXPORT - FLOW TO WEST PORTAL

Values in Acre-Feet

Water Year (1)	Flow From Grant Lake (2)	Release to Mono Lake (Mono Gate #1) (3)	Export Flow to West Portal (4)	Cumulative Export (5)
1974-75	123,000	0	123,000	2,255,000
76	76,000	0	76,000	2,331,000
77	45,000	0	45,000	2,376,000
78	113,000	15,000	98,000	2,474,000
79	141,000	0	141,000	2,615,000
1979-80	128,000	39,000	89,000	2,704,000
81	109,000	0	109,000	2,813,000
82	122,000	19,000	103,000	2,916,000
83	149,000	149,000	0	2,916,000
84	131,000	86,000	45,000	2,961,000
1984-85	119,000	18,000	101,000	3,062,000
1941-85 Total	3,888,000	1,038,000	3,062,000	3,062,000
46-Yr. Average	86,400	23,100	68,100	68,000
1970-85 Total	1,799,000	358,000	1,441,000	1,441,000
16-Yr. Average	112,400	22,400	90,100	90,100
1941-76 Total	3,211,000	880,000	2,331,000	2,331,000
36-Yr. Average	89,200	24,400	64,800	64,800
1941-70 Total	2,584,000	876,000	1,708,000	1,708,000
30-Yr. Average	86,100	29,200	56,900	56,900

TABLE 7

MONO BASIN

CAIN RANCH PRECIPITATION

Water Year	Seasonal Precipitation Inches (1)	% of Mean (2)	Departure From Mean % (3)	Accumulated Departure From Mean % (4)
32	15.91	139	+39	0
33	7.54	66	-34	+5
34	7.78	68	-32	-27
1934-35	15.18	133	+33	+6
36	9.23	81	-19	-13
37	13.35	117	+17	+4
38	22.70	198	+98	+102
39	8.24	72	-28	+74
1939-40	7.82	68	-32	+42
41	14.26	125	+25	+67
42	10.56	92	-8	+59
43	10.30	90	-10	+49
44	8.17	71	-29	+20
1944-45	12.58	110	+10	+30
46	11.36	99	-1	+29
47	11.13	97	-3	+26
48	5.71	50	-50	-24
49	8.87	76	-24	-48
1949-50	6.63	58	-42	-90
51	12.30	108	+8	-82
52	18.94	166	+66	-16
53	6.14	54	-46	-62
54	8.16	71	-29	-91
1954-55	8.40	73	-27	-118
56	17.01	149	+49	-69
57	9.98	87	-13	-82
58	15.31	134	+34	-48
59	9.05	79	-21	-69
1959-60	4.23	37	-63	-132
61	9.67	85	-15	-147
62	13.80	121	+21	-126
63	15.26	133	+33	-93
64	8.63	75	-25	-118
1964-65	12.32	108	+8	-110
66	10.74	94	-6	-116
67	16.90	148	+48	-68
68	5.26	46	-54	-122
69	16.87	147	+47	-75

TABLE 7 (Cont.)

MONO BASIN

CAIN RANCH PRECIPITATION

Water Year	Seasonal Precipitation Inches (1)	% of Mean (2)	Departure From Mean % (3)	Accumulated Departure From Mean % (4)
1969-70	8.52	74	-26	-101
71	8.62	75	-25	-126
72	9.86	86	-14	-140
73	11.88	104	+4	-136
74	12.94	115	+15	-121
1974-75	13.19	116	+16	-105
76	8.25	72	-28	-133
77	6.65	58	-42	-175
78	19.52	171	+71	-104
79	12.25	107	+7	-97
1979-80	15.91	139	+39	-58
81	8.18	72	-28	-86
82	20.44	179	+79	-7
83	16.67	146	+46	+39
84	11.26	98	-2	+37
1984-85	7.47	65	-35	+2
TOTAL	617.89			
54 Yr. Mean	11.44 Inches	100.0		

1941-85 Total 510.14	
45-Yr. Average 11.34	99.1
1941-70 Total 411.35	
30-Yr. Average 11.42	99.8
1941-76 Total 391.79	
36-Yr. Average 10.88	95.1
1970-85 Total 191.61	
16-Yr. Average 11.98	104.7

TABLE 8

MONO BASIN

GEM LAKE PRECIPITATION

Water Year	Seasonal Precipitation Inches (1)	% of Mean (2)	Departure From Mean % (3)	Accumulated Departure From Mean % (4)
1925-26	28.43	130	+30	0
27	31.29	143	+43	+73
28	25.83	118	+18	+91
29	20.55	94	-6	+85
1929-30	22.86	105	+5	+90
31	19.44	89	-11	+79
32	27.17	125	+25	+104
33	16.69	77	-23	+81
34	16.96	78	-22	+59
1934-35	28.22	129	+29	+88
36	25.12	115	+15	+103
37	24.72	113	+13	+116
38	34.17	157	+57	+173
39	17.37	80	-20	+153
1939-40	29.09	133	+33	+186
41	37.68	173	+73	+259
42	29.77	136	+36	+295
43	28.72	132	+32	+327
44	23.53	108	+8	+335
1944-45	28.03	129	+29	+364
46	20.62	95	-5	+359
47	16.12	74	-26	+333
48	13.05	60	-40	+293
49	13.64	63	-37	+256
1949-50	13.74	63	-37	+219
51	20.52	94	-6	-213
52	29.40	135	+35	+248
53	19.10	88	-12	+236
54	12.40	57	-43	+193
1954-55	13.87	64	-36	+157
56	23.79	109	+9	+166
57	11.46	53	-47	+119
58	17.54	80	-20	+99
59	14.08	65	-35	+64

TABLE 8 (Cont.)

MONO BASIN

GEM LAKE PRECIPITATION

Water Year	Seasonal Precipitation Inches (1)	% of Mean (2)	Departure From Mean % (3)	Accumulated Departure From Mean % (4)
1959-60	10.40	48	-52	+12
61	15.16	70	-30	-18
62	20.29	93	-7	-25
63	21.99	101	+1	-24
64	15.92	73	-27	-51
1964-65	25.49	117	+17	-34
66	21.26	97	-3	-37
67	30.38	139	+39	+2
68	12.24	56	-44	-42
69	32.57	149	+49	+7
1969-70	13.02	60	-40	-33
71	20.50	94	-6	-39
72	17.26	79	-21	-60
73	19.82	91	-9	-69
74	21.38	98	-2	-71
1974-75	21.04	96	-4	-75
76	15.01	69	-31	-106
77	9.33	43	-57	-163
78	28.95	133	+33	-130
79	18.66	86	-14	-144
1979-80	23.90	110	+10	-134
81	12.54	57	-43	-177
82	42.08	193	+93	-84
83	40.61	186	+86	+2
84	24.89	114	+14	+16
1984-85	19.12	88	-12	+4
(1926-85) TOTAL	1308.78			
60 Year Mean	21.81 Inches	100		

1941-85 Total	940.87	
45-Yr. Average	20.91	95.9
1941-70 Total	605.78	
30-Yr. Average	20.19	92.6
1941-76 Total	720.79	
36-Yr. Average	20.02	91.8
1970-85 Total	348.11	
16-Yr. Average	21.76	99.8

TABLE 9

MONO BASIN

GRANT LAKE EVAPORATION

Water Year	4 month* land pan evaporation (in.)	% of mean (36 yr avg)	% of mean (45 yr avg)
1940-41	24.8	0.98	0.95
42	24.3	0.96	0.93
43	24.9	0.98	0.96
44	26.0	1.02	1.00
1944-45	22.4	0.88	0.86
46	24.0	0.94	0.92
47	25.3	1.00	0.97
48	26.4	1.04	1.02
49	25.7	1.01	0.99
1949-50	23.3	0.92	0.90
51	25.1	0.99	0.97
52	22.8	0.90	0.88
53	21.6	0.85	0.83
54	25.1	0.99	0.97
1954-55	25.5	1.00	0.98
56	25.9	1.02	1.00
57	26.5	1.04	1.02
58	24.2	0.95	0.93
59	26.4	1.04	1.02
1959-60	26.9	1.06	1.03
61	22.0	0.87	0.84
62	25.9	1.02	1.00
63	26.1	1.03	1.00
64	26.7	1.05	1.03
1964-65	28.7	1.13	1.10
66	29.7	1.17	1.14
67	25.3	1.00	0.97
68	28.9	1.14	1.11
69	23.9	0.94	0.92

* 4 month measurement includes June, July, August, and September of each year.

TABLE 9 (Cont.)

MONO BASIN

GRANT LAKE EVAPORATION

Water Year	4 month* land pan evaporation (in.)	% of mean (36 yr avg)	% of mean (45 yr avg)
1969-70	28.7	1.13	1.10
71	25.5	1.00	0.98
72	27.7	1.09	1.07
73	25.0	0.98	0.96
74	24.9	0.98	0.96
1974-75	24.8	0.98	0.95
76	23.1	0.91	0.89
77	26.7	1.05	1.03
78	23.5	0.93	0.90
79	32.7	1.29	1.26
1979-80	29.9	1.18	1.15
81	32.0	1.26	1.23
82	28.4	1.11	1.09
83	28.7	1.13	1.10
84	25.4	1.00	0.98
1984-85	27.8	1.09	1.07
1941-85 total	1,169.10		
45 yr. mean	26.0		
1941-76 total	914.0		
36 yr. mean	25.4		

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* 4 month measurement includes June, July, August, and September of each year.

TABLE 10

MONO BASIN
CHEMICAL ANALYSIS OF SURFACE WATERS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as CaCO$_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co$_3$	HCo$_3$	SO$_4$	Cl	No$_3$					
204 Rush Crkl[a]	11/11/67	427,000	11.0	6.98	47	$\frac{6.0}{0.3}$	$\frac{2.4}{0.2}$	$\frac{1.8}{0.08}$	$\frac{1.0}{0.03}$	0	0	$\frac{36.6}{0.60}$	$\frac{4.0}{0.08}$	$\frac{1.2}{0.03}$	0	0	0	44	25	16
205 LvCkDam[a]	11/11/67	6,300	5.0	7.44	45	$\frac{6.4}{0.32}$	0	$\frac{3.0}{0.13}$	$\frac{1.2}{0.03}$	0	0	$\frac{14.6}{0.24}$	$\frac{2.0}{0.04}$	$\frac{1.0}{0.03}$	0	0	0	31	16	28
210 Andy Thom[a]	12/11/67	14,200	3.0	8.06	43	$\frac{6.4}{0.32}$	$\frac{1.0}{0.08}$	$\frac{3.2}{0.14}$	$\frac{1.7}{0.04}$	0	0	$\frac{36.6}{0.60}$	$\frac{2.0}{0.04}$	$\frac{3.0}{0.09}$	0	0	0	49	20	26
211 WWilsCkl[a]	12/11/67	41,000	6.5	7.40	122	$\frac{20.0}{1.0}$	$\frac{1.0}{0.08}$	$\frac{6.4}{0.28}$	$\frac{2.4}{0.06}$	$\frac{0.1}{.005}$	0	$\frac{51.3}{0.84}$	$\frac{9.0}{0.19}$	$\frac{1.5}{0.04}$	0	0.1	0	81	54	21
212 MillCrkl[a]	12/11/67	14,200	8.5	7.28	60	$\frac{10.0}{0.5}$	$\frac{1.2}{0.1}$	$\frac{2.8}{0.12}$	$\frac{1.0}{0.03}$	$\frac{0.1}{.005}$	0	$\frac{29.3}{0.48}$	$\frac{8.0}{0.17}$	$\frac{2.5}{0.07}$	0	0.1	0	52	30	19
Rush Crk@[c] Silver Lk	July 1928	--	--	6.6	--	$\frac{1.2}{0.06}$	$\frac{1.1}{0.09}$	$\frac{10.4}{0.45}$	0	--	0	$\frac{11.6}{0.19}$	$\frac{3.1}{0.06}$	$\frac{6.0}{0.17}$	0	--	0	42	8	75
Rush Creek[c] at outlet fr Grt Lk	1934-35	--	--	7.3	64	$\frac{10}{0.50}$	$\frac{4}{0.33}$	$\frac{7}{0.30}$	--	--	0	$\frac{38}{0.62}$	$\frac{3}{0.06}$	$\frac{9}{0.25}$	--	--	0.04	52	42	27
Rush Creek[c] at outlet fr Grt Lk	1958-59	--	--	7.4	80	$\frac{7}{0.35}$	$\frac{0.72}{0.06}$	$\frac{3}{0.13}$	$\frac{1}{0.03}$	--	0	$\frac{24}{0.38}$	$\frac{4}{0.08}$	$\frac{4.7}{0.13}$	--	0	--	32	21	23
Bridgeport[c] Crk @Co.Rd.	7/6/60	--	--	7.2	448	$\frac{33}{1.65}$	$\frac{14}{1.15}$	$\frac{47}{2.04}$	$\frac{12}{0.31}$	--	0	$\frac{281}{4.60}$	$\frac{3}{0.07}$	$\frac{13}{0.37}$	$\frac{0.6}{0.01}$	0.44	0.18	310	138	40
L.V.Creek[b] @Aq.Intake	9/13/73	--	25.0	7.45	51	--	--	--	--	--	0[d]	$\frac{18.3}{0.3}$	--	$\frac{0.1}{.003}$	$\frac{0.3}{.005}$	.1	.01	--	16	--

TABLE 10 (cont.)

MONO BASIN
CHEMICAL ANALYSIS OF SURFACE WATERS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total^e Hardness as CaCO$_3$ ppm	%Na^f
						Ca	Mg	Na	K	Fe	Co$_3$	HCo$_3$	SO$_4$	Cl	No$_3$					
Walker Crk^b @ Aq.Intake	9/13/73	--	25	7.55	42	--	--	--	--	--	0^d	$\frac{11.22}{0.18}$	--	$\frac{0.4}{0.01}$	$\frac{0.2}{.003}$	<.1	<.01	--	10	--
Parker Crk^b @Aq.Intake	9/13/73	--	25	7.50	63	--	--	--	--	--	0^d	$\frac{22.0}{0.36}$	--	$\frac{<0.1}{<.01}$	$\frac{0.1}{.002}$	<.1	<.01	--	20	--
Lee Vining^b Intake	4/21/81	20,000	--	7.90	60	$\frac{8.4}{0.42}$	$\frac{0.5}{0.04}$	$\frac{2.5}{0.11}$	$\frac{0.5}{0.01}$	--	--	--	$\frac{5.4}{0.11}$	--	$\frac{0.3}{0.005}$	--	0	--	23	21
Grant Lake^b Inflow	4/21/81	25,600	--	7.80	55	$\frac{7.2}{0.36}$	$\frac{0.5}{0.04}$	$\frac{4.0}{0.17}$	$\frac{0.5}{0.01}$	--	--	--	$\frac{5.8}{0.12}$	--	$\frac{0.3}{0.005}$	--	0	--	21	33
S. Parker^b Creek	4/21/81	290	--	7.85	81	$\frac{10}{0.5}$	$\frac{1.5}{0.12}$	$\frac{5.5}{0.24}$	$\frac{1.5}{0.04}$	--	--	--	$\frac{7.8}{0.16}$	--	$\frac{2.0}{0.03}$	--	0	--	28	30
Rush Creek^b at Dam	4/21/81	49,100	--	7.90	69	$\frac{9.6}{0.48}$	$\frac{0.8}{0.04}$	$\frac{2.5}{0.11}$	$\frac{0.8}{0.02}$	--	--	--	$\frac{3.2}{0.07}$	--	$\frac{0.3}{.005}$	--	.03	--	26	18
Parker Cr^b at Intake	4/21/81	3,120	--	7.85	68	$\frac{8.8}{0.44}$	$\frac{0.8}{0.07}$	$\frac{4.0}{0.17}$	$\frac{0.8}{0.02}$	--	--	--	$\frac{6.8}{0.14}$	--	$\frac{0.4}{.006}$	--	.03	--	24	28
Walker Cr^b at Intake	4/21/81	710	--	7.80	56	$\frac{6.0}{0.3}$	$\frac{0.5}{0.04}$	$\frac{5.2}{0.23}$	$\frac{0.8}{.02}$	--	0^d	$\frac{23.2}{0.38}$	$\frac{5.1}{0.11}$	0.7	$\frac{0.2}{.003}$	--	.02	--	17	42
Wilson^b Creek	8/21/85	7,800	25.2	7.70	110	$\frac{14.0}{.70}$	$\frac{1.2}{.04}$	$\frac{2.3}{.10}$	$\frac{0.9}{.02}$	$\frac{0.02}{.00}$	--	$\frac{36.0}{.72}$	$\frac{8.5}{.18}$	$\frac{1.4}{0.4}$	$\frac{0.01}{.00}$	.19	.01	86	40	12.5
Log Cabin^b Creek	8/21/85	--	25.2	7.42	64	$\frac{7.0}{.35}$	$\frac{1.1}{.04}$	$\frac{3.4}{.15}$	$\frac{0.8}{.02}$	$\frac{0.01}{.00}$	--	$\frac{22.0}{.44}$	$\frac{6.5}{.14}$	$\frac{1.4}{.04}$	$\frac{0.01}{.00}$	.16	.025	56	22	27.6
Rush^b Creek	8/21/85	--	25.2	7.33	39	$\frac{4.0}{.20}$	$\frac{0.6}{.02}$	$\frac{1.2}{.05}$	$\frac{0.5}{.01}$	$\frac{0.01}{.00}$	--	$\frac{13.0}{.26}$	$\frac{5.0}{.10}$	$\frac{2.1}{.06}$	$\frac{0.03}{.00}$	.13	.015	40	12	13.2
Walker^b Creek	8/21/85	--	25.2	6.76	32	$\frac{2.0}{.10}$	$\frac{1.5}{.05}$	$\frac{3.6}{.16}$	$\frac{0.7}{.02}$	$\frac{0.03}{.00}$	--	$\frac{10.0}{.20}$	$\frac{5.4}{.11}$	$\frac{1.4}{.04}$	$\frac{0.02}{.00}$	.14	.015	36	12	46.2

TABLE 10 (cont.)

MONO BASIN
CHEMICAL ANALYSIS OF SURFACE WATERS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
Lee Vining[b] Creek	8/22/85	69,600	25.2	7.06	28	2.0 .10	1.5 .05	1.9 .08	0.4 .01	0.03 .00	--	10.0 .20	5.0 .10	1.4 .04	.12 .00	.10	.01	32	12	32.8
Mill[b] Creek	8/22/85	4,100	25.2	7.21	67	8.0 .40	1.0 .04	1.6 .07	0.8 .02	0.05 .00	--	22.0 .44	8.4 .17	2.1 .06	.01 .00	.13	.01	64	24	14.0
Virginia[b] Creek	8/22/85	900	25.2	7.26	69	8.0 .40	1.5 .05	6.7 .29	2.1 .05	0.05 .00	--	22.0 .44	2.1 .04	2.1 .06	.02 .00	.11	.01	68	26	36.6
Parker[b] Creek	8/22/85	9,400	25.2	7.20	52	6.0 .30	2.0 .07	.84 .04	0.8 .02	0.06 .00	--	18.0 .36	1.4 .03	1.4 .04	.05 .00	.11	.02	60	22	8.7
Log Cabin[b] Creek	8/19/86	673	24	7.48	44	5.6 .28	1.0 .08	2.0 .09	0.7 .02	--	--	--	3.0 .07	0.1 0	<.01	0.1	.05	34.0	18	22
Andy Thom[b] Creek	8/19/86	898	24	7.51	48	5.6 .28	2.4 .20	2.2 .10	0.7 .02	--	--	--	1.5 .03	<.01	<.01	0.1	.01	52.0	20	20

(a) Lee, Keenan, "Infared Exploration for Shorline Springs at Mono Lake California, Test Site", Stanford RSL Technical Report 69-7, September 1969.

(b) Los Angeles Department of Water and Power records.

(c) California Department of Water Resources, Southern California District, "Reconnaissence investigation of Water Resources of Mono and Owens Basins, Mono and Inyo Counties", August 1960.

(d) Although carbonate (CO_3^{-2}) alkalinity was not measured, total alkalinity was assumed to be bicarbonate (HCO_3-) and carbonate alkalinity to be negligible for pH less than 8.

(e) Total hardness as $CaCo_3$ = 2.5 Ca(ppm) + 4.1 Mg(ppm)

(f) $\%\text{Na} = \frac{\text{Na}}{\text{Ca + Mg + Na + K}}$ X 100 (ppm)

(g) Flow rate measured in June 1981 by DWP Hydrographer

TABLE 11

MONO BASIN
CHEMICAL ANALYSIS OF WELLS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
LeeVining[b] Test Well	9/11/80	449	25.0	8.20	352	25.0 1.25	13.0 1.17	29.0 1.26	3.0 .08	.01 0	0	160.0 2.62	12.0 0.25	8.9 0.25	1.4 .02	0.31	0.30	--	--	41
Danburg Bch[b] Supply Well	4/21/81	--	--	8.40	240	22.0 1.10	1.40 .11	25.0 1.09	3.2 .08	--	--	93.0 1.52	20.0 0.42	3.9 0.11	1.0 .01	--	0.18	--	--	48
213 Dachambo[a]	11/12/67	950	65.5	7.10	1835	16.0 0.8	2.4 0.2	390.0 17.0	8.5 0.22	0.1 .005	0	402.6 6.6	90.0 1.87	330.0 9.42	0.9 0.01	4.0	5.8	1130	50	94
214 NB Aikken[a]	11/13/67	130	13.0	9.57	731	2.0 0.1	0.2 0.02	160 7.0	14.0 0.37	0	45.6 1.52	224.5 3.68	70.0 1.46	20.0 0.57	3.5 0.06	0.6	0.6	486	5.8	91
217 GW TTTT[a]	10/9/67	--	14.0	--	483	74.0 3.7	9.6 0.80	26.0 1.13	3.1 .082	0	0	195.2 3.2	120.0 2.5	.50 0.14	3.5 0.06	0.7	0	393	220	23
304 Tyree217[a]	2/21/68	--	13.2	9.55	1487	2.2 0.11	0	288.0 12.5	30.0 0.79	0.3 0.02	48.0 1.60	712.0 11.7	110.0 2.29	135.0 3.86	0	0.8	1.8	781	5.5	90
309 Tyraetoo[a]	2/22/68	--	16.9	7.20	390	9.6 0.48	10.1 0.84	47.0 2.04	12.0 0.32	0.3 0.02	0	170.8 2.80	13.0 0.27	18.0 0.51	0.4 .006	0.2	0.2	237	65	59
315 Wtrwell 1[a]	2/24/68	--	11.4	7.60	272	22.0 1.1	6.0 0.5	25.0 1.09	2.6 .068	0.3 0.02	0	122.0 2.0	20.0 0.42	7.5 0.21	7.9 0.13	0.5	0	178	80	45
403 CainRnch[a]	5/5/68	--	10.5	7.73	117	12.8 0.64	1.4 0.12	9.4 0.41	2.9 .076	0	0	54.9 0.90	9.0 0.19	4.8 0.14	0.4 .006	0.2	0	108	38	35
404 Lundylnd[a]	5/5/68	--	--	7.78	99	11.2 0.56	1.9 0.16	6.0 0.26	1.2 .032	0	0	42.7 0.7	9.0 0.19	2.4 0.07	0	0.1	0	74	36	30
410 Raedpond[a]	5/8/68	32	12.4	8.77	607	11.6 0.58	4.1 0.34	110.0 4.78	14.0 0.37	0	0	256.2 4.20	50.0 1.04	22.0 0.63	0	0.2	0	390	46	79
503 Nettault[a]	6/27/68	32	16.0	7.94	570	8.0 0.4	1.0 0.083	110.0 4.78	18.3 0.48	0	24.0 0.80	258.6 4.24	27.0 0.56	36.4 1.04	0	0	0	394	24	80

TABLE 11 (cont.)

MONO BASIN
CHEMICAL ANALYSIS OF WELLS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total^e Hardness as $CaCO_3$ ppm	%Na^f
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
504 Tomsult^a	6/28/68	280	14.2	9.43	626	4.8 0.24	1.0 .083	126.0 5.48	19.6 0.52	0	44.9 1.50	128.3 2.10	92.0 1.92	28.0 0.80	0	0	0	406	16	83
505 Annadias^a	6/28/68	16	16.4	--	545	4.8 0.24	0.5 0.04	110.0 4.78	17.6 0.46	0	14.4 0.48	258.6 4.24	43.0 0.90	25.0 0.71	0	0	0	386	14	83
512 WWN 2^a	8/8/68	--	15.7	9.82	18599	0.5 .025	2.6 0.22	3940.0 171	268.0 7.05	0	1668.0 55.6	1500.6 24.6	2430.0 50.6	2380.0 68.0	0	16.6	102.0	11555	12	94
513 WWE10^a	8/14/68	--	11.4	9.09	--	2.4 0.12	0.5 0.04	780.0 33.9	48.0 1.26	0	177.6 5.92	829.6 13.6	200.0 4.12	407 11.63	0	0	0	2057	8	94
514 WWE 7^a	8/14/69	--	22.6	8.73	1859	2.4 0.12	1.4 0.12	438.0 19.0	37.6 1.00	0	72.0 2.4	658.8 10.8	155.0 3.23	186.0 5.31	0	0	0	1254	12	91
515 Tyree 217^a	8/19/68	--	13.3	9.41	1239	0.8 0.04	0.1 .008	268.0 11.6	26.7 0.70	0	14.4 0.48	258.6 4.24	135.0 2.81	140.0 4.0	0	0	0	746	2.4	91
516 Tyreeton^a	8/19/68	--	17.6	7.51	347	6.4 0.32	3.8 0.32	42.4 1.84	11.6 0.31	0	0	136.6 2.24	19.0 0.40	22.0 0.63	0	0	0	227	32	66
601 Paoha^a	5/24/68	--	18.6	7.50	1487	28.8 1.44	9.6 0.80	300.0 13.0	50.0 1.32	0	0	766.2 12.6	10.0 0.21	156.0 4.46	0	0	0	1045	110	77
602 Kelly's^a	5/26/68	--	11.8	7.21	743	97.6 4.88	4.8 0.40	45.0 2.00	12.0 0.32	0	0	361.1 5.92	81.0 1.69	34.0 0.97	0	0	0	479	260	28
603 highway 3^a	5/28/68	--	15.5	8.48	384	12.8 0.64	6.7 0.56	56.0 2.43	11.0 0.29	0	0	175.7 2.88	29.0 0.60	14.0 0.40	0	0	0	274	59	65
604 Chas Crow^a	5/28/68	--	15.0	7.01	433	17.6 0.88	12.5 1.04	33.0 1.43	8.0 0.21	0	0	205.0 3.36	9.0 0.19	10.0 0.29	0	0	0	265	95	46

TABLE 11 (cont.)

MONO BASIN
CHEMICAL ANALYSIS OF WELLS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
1N/26E-5J1[c] 1.2 mi N & 0.3 mi W of Lee Vining	6/23/60	--	--	7.5	236	$\frac{3.4}{1.70}$	$\frac{2}{0.2}$	$\frac{9}{0.41}$	$\frac{3.1}{0.08}$	--	0	$\frac{140}{2.30}$	$\frac{4}{0.08}$	$\frac{4}{0.10}$	$\frac{5}{0.08}$	0.2	0.34	238	95	17
1N/28E-5E1[c] 10.8 mi E & 1.4 mi N of Lee Vining	7/6/60	--	12	7.1	100	$\frac{5}{0.25}$	$\frac{3}{0.25}$	$\frac{12}{0.52}$	$\frac{1.0}{0.03}$	--	0	$\frac{56}{0.92}$	0	$\frac{4}{0.11}$	$\frac{2.0}{0.03}$	0.2	0	105	25	50
2N/26E-20E1[c] 4.3 mi N & 1 mi W of Lee Vining	6/23/60	--	--	7.6	136	$\frac{20}{1.0}$	$\frac{5}{0.40}$	$\frac{5}{0.20}$	$\frac{1.2}{0.03}$	--	0	$\frac{73}{1.20}$	$\frac{1}{0.03}$	$\frac{7}{0.20}$	$\frac{4}{0.06}$	0.1	.02	64	70	12
3N/27E-35B1[c] 8.5 mi E & 8.5 mi N of Lee Vining	7/6/60	--	13	9.4	739	$\frac{0.8}{0.04}$	$\frac{0.5}{0.04}$	$\frac{172}{7.48}$	$\frac{15}{0.38}$	--	$\frac{62}{2.08}$	$\frac{224}{3.68}$	$\frac{71}{1.47}$	$\frac{24}{0.68}$	$\frac{0.5}{0.01}$	0.8	1.0	490	4	94

(a) Lee, Keenan, "Infared Exploration for Shoreline Springs at Mono Lake California, Test Site", Stanford RSL Technical Report 69-7, September 1969.

(b) Los Angeles Department of Water and Power records.

(c) California Department of Water Resources, Southern California District, "Reconnaissance Investigation of Water Resources of Mono and Owens Basins, Mono and Inyo Counties", August 1960.

(d) Although carbonate ($CO_3{-}^2$) alkalinity was not measured, total alkalinity was assumed to be bicarbonate (HCO_3^-) and carbonate alkalinity to be negligible for pH less than 8.

(e) Total Hardness as $CaCO_3$ = 2.5 Ca(ppm) + 4.1 Mg(ppm)

(f) $\%Na = \frac{Na}{Ca + Mg + Na + K} \times 100$ (ppm)

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
201 Hot Spg 2[a] Sec 17,TIN R27E	11/11/67	32	36.5	7.10	3223	112.0 5.6	24.0 1.96	700.0 30.4	46.0 1.18	0.2 .01	0	1610.4 26.4	120.0 2.50	190.0 5.34	0	1.8	0	2077	380	77.7
203 Hot Spg 1[a] Sec 17,TIN R26E	11/11/67	16	41.5	6.57	2851	180.0 9.0	38.4 3.15	510.0 22.2	43.0 1.10	0.1 .005	0	1830.0 30	48.0 1.0	85.0 2.40	7.5 .15	1.1	4.2	1914	610	62.6
206 Charlie[a] Sec 5,TIN R26E	11/11/67	160	18.0	9.49	303	2.4 .12	1.0 .08	64.0 2.78	2.9 .07	0	24.0 .80	85.4 1.4	19.0 .40	6.9 .20	0.4 .006	0	0.3	189	9.1	91.1
207 W Shore[a] Sec 30,TIN R2	11/11/67	16	9.5	9.47	2851	6.0 0.3	3.6 .30	680.0 29.57	46.0 1.18	0	60.0 2.00	524.6 8.6	750.0 15.6	190.0 5.34	1.8 .029	3.5	6.8	2029	30	94.3
208 W Shore 2[a] Sec 30,TIN R26E	11/12/67	400	18.0	9.39	365	0.5 .025	0.5 .04	9.2 0.4	1.2 .03	0	48.0 1.60	85.4 1.40	18.0 .375	5.9 .17	0	0.2	0.3	227	3.3	91.0
209 W Shore 5[a] Sec 31,T2N R26E	11/12/67	950	22.0	9.52	613	0.6 .03	0.1 .01	130.0 5.65	11.0 .28	0	114.0 3.80	54.9 .90	32.0 .67	12.0 .34	4.4 .071	0.9	0.2	356	1.9	94.6
215 Wrm Spg 3[a] Sec 17,T2N R28E	11/13/67	60	31.0	6.56	2975	92.6 4.6	37.2 3.05	600.0 26.09	54.0 1.38	0.1 .005	0	1500.6 24.6	91.0 1.90	196.0 5.53	4.4 .071	0	8.4	1930	380	74.3
216 Samon[a] Sec 6,TIN R28E	11/13/67		12.6	9.70	2727	14.0 0.7	4.8 .39	650.0 28.26	58.0 1.48	0	312.0 10.4	414.8 6.8	180.0 3.75	280.0 7.90	2.6 .042	1.8	12.0	1789	55	91.6
302 So Shore 1[a] Sec 12,TIN R27E	2/21/68	480	12.0	7.40	297	20.8 1.04	11.0 .90	19.0 .83	2.7 .07	0	0	158.6 2.6	1.0 .02	3.6 .10	0.9 .015	0.2	0	216	97	29.1
303 Warm Spg 4[a] Sec 17,T2N R28E	2/21/68	320	31.4	6.95	3471	248.0 12.4	9.6 .79	472.0 20.52	38.0 .97	0.1 .005	0	1756.8 28.80	2.0 0.4	180.0 5.08	5.7 .092	1.3	3.6	[illegible]	[illegible]	[illegible]

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
305 Covote[a] Sec 14,T3N R26E	2/22/68	50	8.6	7.10	454	41.6 2.08	15.8 1.30	22.0 1.00	3.3 .08	0	0	244.0 4.00	6.0 .125	8.4 .24	0	0.2	0	259	170	21.7
306 Bdgprt Cy[a] Sec 15,T3n R26E	2/22/68	16	7.8	7.50	347	29.6 1.48	13.4 1.10	16.0 .70	2.4 .06	0	0	183.0 3.0	6.0 .125	9.0 .25	0.9 .015	0.1	0	211	130	20.8
307 W Burkham[a] Sec 15,T3N R27E	2/22/68	16	17.3	7.7	272	3.4 .17	2.1 .17	44.0 1.91	8.1 .21	0	0	128.1 2.00	7.0 .15	9.0 .25	1.3 .021	0.4	0	189	17	77.7
308 Burkham[a] Sec 15,T3N R27E	2/22/68	0	16.4	7.85	272	4.0 0.2	1.7 .14	41.0 1.78	9.1 .23	0	0	128.1 2.10	7.0 .15	8.4 .24	0.9 .015	0.2	0.4	186	17	75.6
310 Brdgpt Dl[a] Sec 31,T3N R27E	2/22/68	0	10.0	8.50	--	12.0 0.6	5.3 .43	750.0 32.61	64.0 1.64	0	129.6 4.32	1188.3 19.5	92.0 1.92	290.0 8.18	21.1 .34	1.2	12.0	1972	52	92.4
311 Lv Delta 3[a] Sec 4,T1N R26E	2/22/68	0	10.6	7.50	471	40.8 2.04	9.6 .79	34.0 1.48	3.8 .10	0	0	225.7 3.70	10.0 .21	13.0 .37	0	0.1	0	256	140	33.6
312 Mono Visa[a] Sec 20,T2N R26E	2/23/68	0	9.7	7.35	154	18.4 .92	1.0 .08	6.0 .26	1.6 .04	0	0	73.2 1.20	9.0 .19	2.4 .067	0.4 .006	0.1	0	93	50	20.1
517 MVSUB6[a] Sec	8/3/81	0	13.9	0.0	123998	0	94.6 7.75	26800 1170	1450 37.1	0	14460 482	4819 79	15400 321	17000 480	0	43.9	269	78487	390	96.3
518 Waford[a] Sec 28,T3N R27E	6/1/69	0	11.8	8.20	322	25.6 1.28	4.8 .39	29.0 1.26	11.0 .28	0	0	180.6 2.96	18.0 .375	10.0 .28	0	0.0	0.0	238	84	39.2

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
314 Bk Pt A[a] Sec 21,T2N R26E	2/23/68	650	10.4	8.05	204	21.6 1.08	1.0 .08	13.0 .57	2.0 .05	0	0	0	79.3 1.65	12.0 .34	0.4 .006	0.1	0	109	58	31.9
401 Mv Sub 1[a] Sublacstrne Near Danburg Beach	5/5/68	0	9.6	0	--	0	47.7 3.85	27000 1170	1540.0 39.4	0	12240 408	4880 80	10400 217	16480 465	1.3 .21	44.0	0	70152	193	96.4
402 BP TT 5[a] Sublacstrne Near Black Point	5/5/68	0	10.9	8.49	198	18.4 .92	1.4 .11	21.0 .91	3.0 .08	0	0	97.6 1.6	14.0 .29	4.8 .14	0.4 .006	0	0	127	52	45.1
405 BP TT 1[a] Sublacstrne Near Black Point	5/7/68	630	11.4	8.58	198	17.6 .88	1.0 .08	24.0 1.04	3.1 .08	0	0	97.6 1.6	17.0 .35	3.6 .10	0	0	0	131	48	50.2
406 BP TT 3[a] Sublacstrne Near Black Point	5/7/68	190	10.4	8.64	173	22.4 1.12	2.4 .20	15.0 .65	5.3 .14	0	0	97.6 1.6	12.0 .25	3.6 .10	0.4 .006	0	0	126	660	31.0
407 BP TT 4[a] Sublacstrne Near Black Point	5/7/68	0	11.3	0	99199	0	37.9 3.11	2000.0 87.0	1060.0 27.1	0	10800 360	976.0 16	8000 167	12240 345	0.9 .015	36.0	0	52655	160	96.6
408 MV Sub 7[a] Sublacstrne near Danburg Beach	5/7/68	0	10.4	0	--	0	48.0 3.93	27200 11800	1430 36.6	0	14150 472	3172 52	12000 250	16800 474	1.3 .21	44.0	0	73244	200	96.7
409 MV Sub 4[a] Sublacstrne Near Danburg Beach	5/7/68	0	0	0	--	0	47.0 3.85	26700 1160	1400 35.8	0	14400 480	2928 48	12000 250	16800 474	1.3 .21	42.0	0	72831	190	96.7

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
411 Monovisa[a] Sec 19,T2N R26E	10/5/68	440	11.1	8.21	142	16.0 0.8	2.9 .24	9.2 0.4	1.3 .03	0	0	67.1 1.1	8.0 .17	4.8 .14	0.4 .006	0	0	100	52	27.2
501 Solo TT[a] Sublacstrne Near North Shore	6/21/68	0	53.9	7.80	2975	8.0 0.4	6.2 .51	520 22.6	44 1.13	0	28.8 0.96	580.7 9.51	12.0 .25	584.0 16.5	0	0	0	2975	45	91.7
502 Paoha 1[a] Sec 29, T2N R27E	6/21/68	0	75.6	0	40423	0	0	8000 348	305 7.80	0	2270.4 75.68	1859.3 30.48	4310 89.8	6210 175	0	26.5	227	22294	0	97.8
506 Paoha 3[a] Sec 20, T2N R27E	8/2/68	160	7.8	9.80	123998	0	2.2 .18	24200 1050	1240 31.7	0	11520 384	5124 84	11520 240	15300 432	0	38.9	204.3	66545	9	97.1
507 Paoha 1[a] Sec 29, T2N R27F	8/2/68	320	78.3	8.96	30131	0	0	7850 341	330 8.44	0	2424 80.8	3025.6 49.6	4000 83.3	6270 177	0	28.5	102	22583	0	97.6
508 Paoha 5[a] Sec 32, T2N R27E	8/2/68	480	21.6	6.78	1301	63.2 3.16	37.4 3.07	100 4.35	20.4 .52	0	0	607.6 9.96	11.0 .22	32.2 .91	0	0	0	633	310	39.2
509 Ranchera[a] Sec 20, T3N R26E	7/31/68	15.8	13.3	7.41	173	11.2 0.56	2.4 .20	8.2 .36	4.2 .11	0	0	44.5 .73	10.0 .21	10.0 .28	0	0	0	115	38	29.2
510 Murphy[a] Sec 24, T4N R26E	8/4/68	160	11.6	8.40	110	4.0 0.2	4.8 .40	2.2 .43	2.2 .06	0	4.8 .16	39.0 0.64	9.0 .19	8.0 .23	0	0	0	103	30	39.6
511 Dry Creek[a] Sec 23, T1S R28E	8/5/68	80	8.8	7.11	37	1.6 .08	1.0 .08	5.4 .23	3.1 .08	0	0	8.5 .14	7.0 .15	6.0 .17	0	0	0	77	8	49.7

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^{6}	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total^{e} Hardness as $CaCO_3$ ppm	%Na^{f}
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
Teal^{b}	1/19/81	225^{g}	22.0	8.75	463	$\frac{36}{1.8}$	$\frac{17}{1.4}$	$\frac{35}{1.52}$	$\frac{3.6}{.09}$	--	0	$\frac{250}{5.00}$	$\frac{4.2}{.09}$	$\frac{3.6}{.10}$	$\frac{0.2}{.003}$	0.44	--	--	160	38
Goose^{b}	1/26/81	525^{g}	22.0	7.65	636	$\frac{66}{3.3}$	$\frac{30}{2.5}$	$\frac{30}{1.30}$	$\frac{3.7}{.10}$	--	0	$\frac{360}{720}$	$\frac{3.3}{.07}$	$\frac{2.1}{.06}$	$\frac{0.4}{.006}$	0.70	--	--	288	23
Danburg^{b} Beach	1/8/81	1795^{g}	11.0	7.75	240	$\frac{23}{1.15}$	$\frac{1.2}{0.1}$	$\frac{25}{1.09}$	$\frac{3.7}{.10}$	--	0	$\frac{9.3}{1.86}$	$\frac{19}{.40}$	$\frac{11}{.31}$	$\frac{1.3}{.02}$	0.20	--	--	62	47
Kirkwood^{b}	1/9/81	20^{g}	16.0	7.83	198	$\frac{12}{.06}$	$\frac{5.1}{.425}$	$\frac{20}{.87}$	$\frac{5.7}{.15}$	--	0	$\frac{85}{1.70}$	$\frac{5.3}{.11}$	$\frac{4.3}{.12}$	$\frac{0.9}{.01}$	0.16	--	--	51	47
Sulfur Pond^{b}	1/9/81	--	13.0	9.11	762	$\frac{1.6}{.08}$	$\frac{< .1}{.0083}$	$\frac{170}{7.39}$	$\frac{14}{.37}$	--	0	$\frac{285}{5.70}$	$\frac{69}{1.44}$	$\frac{16}{.46}$	$\frac{0.4}{.006}$	0.74	--	--	4	92
Burkham^{b}	1/9/81	215	18.0	8.20	242	$\frac{2.4}{.12}$	$\frac{4.0}{.33}$	$\frac{47}{2.04}$	$\frac{12}{.32}$	--	0	$\frac{102}{2.04}$	$\frac{7.3}{.15}$	$\frac{5.3}{.15}$	$\frac{1.8}{.03}$	0.32	--	--	10	72
Warm^{b} Spring B	1/9/91	--	31.0	7.27	2970	$\frac{52}{2.6}$	$\frac{170}{14.2}$	$\frac{615}{26.7}$	$\frac{12}{1.42}$	--	0	$\frac{1320}{26.4}$	$\frac{75}{1.56}$	$\frac{220}{6.28}$	$\frac{0.4}{.006}$	0.13	--	--	350	69
BLM^{b} Stock Tank	1/9/81	--	12.0	8.10	612	$\frac{11}{.55}$	$\frac{4.4}{.37}$	$\frac{116}{5.04}$	$\frac{15}{.39}$	--	0	$\frac{220}{4.40}$	$\frac{60}{1.25}$	$\frac{22}{.63}$	$\frac{0.3}{.005}$	0.31	--	--	46	79
Sand Flat^{b}	1/9/81	65^{g}	12.0	8.30	420	$\frac{46}{2.3}$	$\frac{1.4}{.12}$	$\frac{26}{1.13}$	$\frac{4.0}{.11}$	--	0	$\frac{225}{4.50}$	$\frac{5.0}{.10}$	$\frac{0.7}{.02}$	$\frac{0.4}{.006}$	0.40	--	--	170	34
Villette^{b}	11/18/81	435	--	8.2	130	$\frac{18}{.9}$	$\frac{1.7}{.14}$	$\frac{6.0}{.26}$	$\frac{1.3}{.03}$	--	0	$\frac{45}{.90}$	$\frac{11}{.002}$	$\frac{0.4}{.01}$	$\frac{<0.1}{.002}$	<.1	--	--	51	22
Danburg^{b} Beach	4/21/81	1795	--	8.4	240	$\frac{22}{1.1}$	$\frac{1.4}{.12}$	$\frac{25}{1.09}$	$\frac{3.2}{.08}$	--	0	$\frac{93}{1.86}$	$\frac{20}{.42}$	$\frac{3.9}{.11}$	$\frac{1.0}{.01}$	--	0.18	--	62	48
Villette^{b}	4/21/81	495	--	8.05	128	$\frac{18}{.9}$	$\frac{1.5}{.12}$	$\frac{5.5}{.24}$	$\frac{1.4}{.04}$	--	0	--	$\frac{12}{.25}$	--	$\frac{0.7}{.01}$	--	.05	--	50	26
Allergy^{b}	5/27/81	0.11^{g}	14.4	8.6	433	$\frac{16}{.80}$	$\frac{1.4}{.12}$	$\frac{82}{3.57}$	$\frac{4.2}{.11}$	--	--	$\frac{182}{2.98}$	$\frac{21}{.44}$	$\frac{15}{.42}$	$\frac{2.0}{.29}$	--	0.4	--	46	79
Frac.Rock 1^{b}	5/27/81	--	22.2	9.4	320	$\frac{3.2}{.16}$	$\frac{<0.1}{.01}$	$\frac{6.8}{.30}$	$\frac{3.0}{.08}$	--	--	$\frac{12.4}{2.03}$	$\frac{25}{.52}$	$\frac{7.1}{.20}$	$\frac{1.4}{.2}$	--	0.31	--	8	52
Frac.Rock 2^{b}	5/27/81	--	17.8	9.5	362	$\frac{1.2}{.06}$	$\frac{<0.1}{.01}$	$\frac{85}{3.70}$	$\frac{8.4}{.21}$	--	--	$\frac{151}{2.48}$	$\frac{20}{.42}$	$\frac{2.5}{.07}$	$\frac{2.0}{.29}$	--	0.18	--	3	90

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
Frac.Rock 8[b]	5/27/81	--	21.1	9.65	624	1.2 0.6	<0.1 0.1	132 5.74	5.1 .13	--	--	255 4.18	35 .73	8.5 .24	0.4 .06	--	0.7	--	3.0	95
Frac.Rock 9[b]	5/27/81	--	18.3	8.45	574	38 1.90	9.8 .81	66 2.87	19 .49	--	--	270 4.43	28 .58	8.5 .24	1.0 .14	--	.85		135	50
L.V.Tufa 1[b]	5/27/81	--	13.3	8.75	611	33 1.65	4.6 .38	96 4.17	9.6 .25	--	--	200 3.28	42 .87	1.8 .05	1.8 .26	--	1.75	--	101	67
L.V.Tufa 2[b]	5/27/81	--	16.7	8.9	637	22 1.10	3.2 .26	110 4.78	93 2.4	--	--	195 3.2	44 .92	54 1.52	1.0 .14	--	1.55	--	67	48
L.V.Tufa 4[b]	5/27/81	--	22.2	9.3	5670	1.6 .08	2.0 .16	1304 56.7	110 2.81	--	--	1680 27.54	540 11.24	639 18.02	12.0 1.71	--	22.8	--	12	92
L.V.Tufa 5[b]	5/27/81	--	13.9	8.5	300	29 1.45	3.9 .32	27 1.17	3.1 .08	-- --	-- --	120 1.97	16 .33	5.3 .15	1.5 .21	--	.15	--	88	43
L.V.Delta1[b]	5/27/81	--	9.0	8.6	362	30 1.50	11.0 .90	30 1.3	3.4 .09	--	--	162 2.66	11 .23	7.4 .21	1.8 .26	--	.34	--	118	40
W. L. V.[b] Delta 1	5/27/81	--	12.2	9.0	306	22 1.10	6.3 .52	31 1.35	6.8 .17	-- --	-- --	122 2.0	16 .33	8.2 .23	2.3 .33	--	.37	--	80	47
W. L. V.[b] Delta 2	5/27/81	--	13.9	8.9	1000	25 1.25	6.8 .56	178 7.74	20.0 .51	--	--	305 5.0	68 1.42	89 2.51	2.4 .34	--	2.8	--	90	77
Wlsn Crk[b] Tufa Stm 1	5/28/81	--	22.0	8.1	202	21 1.05	2.0 .16	19 .83	3.8 .10	--	--	85 1.39	15 .31	1.1 .03	0.6 .09	--	.08	--	60	41
Wlsn Crk[b] Tufa Stm 2	5/28/81	--	22.0	8.55	242	26 1.30	2.4 .20	24 1.05	3.0 .08	--	--	109 1.79	14 .29	1.1 .03	0.5 .07	--	.12	--	76	43
Wlsn Crk[b] Tufa 1	5/28/81	--	22.0	8.4	142	19 .95	1.0 .08	10 .43	1.3 .03	--	--	58 .95	11 .23	1.1 .03	0.8 .11	--	.04	--	52	32
Wlsn Crk[b] Tufa 2	5/28/81	--	22.0	8.4	196	22 1.10	2.2 .18	16 .70	1.7 .04	--	--	85 1.39	13 .27	1.1 .03	0.8 .11	--	.12	--	64	38
Wlsn Crk[b] Tufa 3	5/28/81	--	22.0	8.0	206	8.8 .44	0.7 .06	34 1.48	4.9 .13	--	--	83 1.36	20 .42	0.7 0	0.5 .07	--	.17	--	25	70
Wlsn Crk[b] Tufa 4	5/28/81	--	22.0	8.35	216	23 1.15	2.4 .20	20 .87	2.5 .06	--	--	.93 1.52	15 .31	1.1 .03	<0.1 .01	--	.12	--	68	42
Wlsn Crk[b] Tufa 5	5/28/81	--	22.0	8.75	186	17 .85	1.0 .08	20 .87	2.2 .06	--	--	75 1.23	15 .31	1.1 0.3	1.2 .17	--	.11	--	46	50

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as CaCO$_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co$_3$	HCo$_3$	SO$_4$	Cl	No$_3$					
Bwana[b]	11/18/81	--	7.0	8.35	1390	1.6 .08	4.1 .34	315 13.7	35 .9	.39 .02	--	650 10.66	16 .33	48 1.35	0.93 .13	2.5	2.7	920	21	89
Ojo Negro[b]	11/18/81	--	8.0	8.47	3400	5.6 .28	4.4 .36	798 34.7	91 2.3	.29 .02	--	1460 23.93	35 .73	264 7.45	1.8 .26	1.7	7.0	2250	32	89
VRJ[b]	11/18/81	--	13.0	8.10	875	3.6 .18	4.6 .38	184 8.0	22 .56	.02 0	--	415 6.8	9 .19	30 .85	0.30 .04	1.2	1.5	580	28	86
MRG[b]	11/18/81	--	15.0	8.05	442	16 .80	2.2 .18	84 3.65	5.4 .14	<.01 0	--	196 3.21	20 .42	15 .42	0.10 .01	.56	.78	320	48	78
Seeping[b]	11/18/81	--	17.0	8.14	915	9.6 .48	17 1.40	180 7.83	8.6 .22	.03 0	--	430 7.05	3 .06	43 1.21	0.50 .07	1.4	1.7	610	93	84
Brdgprt[b] Crk	11/18/81	--	13.0	8.9	2000	2.4 .12	4.9 .40	470 20.43	32 .82	.01 0	--	720 11.8	160 3.33	135 3.81	3.1 .44	2.5	9.7	2300	260	92
Perservnc[b]	11/19/81	--	24.0	8.54	1930	9.2 .46	17 1.40	411 17.87	28 .72	.06 0	--	725 11.89	18 .37	210 5.92	1.2 .17	2.9	5.4	1270	92	88
Coyote[b] Marsh	11/19/81	--	15.0	8.10	1850	2.4 .12	16 1.32	370 16.09	48 1.23	.02 0	--	638 10.46	12 .25	217 6.12	0.9 .13	4.1	4.5	1210	72	85
Martini[b]	11/19/81	--	27.0	8.05	2460	12 .60	31 2.55	536 23.3	37 .95	.12 .01	--	1090 17.87	3 .06	212 5.98	1.2 .17	.54	5.4	1560	154	87
Jamie[b] Hot TT	11/19/81	--	55.0	8.04	3000	14 .70	7.3 .60	608 26.43	48 1.23	.01 0	--	500 8.20	3 .06	650 18.33	1.8 .26	4.9	12.0	1860	66	90
Hot TT[b]	11/19/81	--	50.0	8.01	2600	13 .65	10 .82	522 22.7	39 1.0	.03 0	--	530 8.69	4 .08	525 14.81	1.2 .17	2.8	9.7	1630	74	89
Sunset 1[b]	2/16/82	0.15	6.0	8.15	311	11 .55	15 1.23	35 1.52	9.1 .23	.01 0	0	159 2.61	5 .10	7.1 .20	<.01 0	.67	.41	230	88	50
Sunset 2[b]	2/16/82	0.08	4.0	8.10	344	11 .55	15 1.23	37 1.61	9.3 .24	.02 0	0	166 2.72	11 .23	5.0 .14	<.01 0	.67	.41	240	90	51
Sunset 3[b]	2/16/82	0.05	3.0	7.98	342	14 .70	17 1.40	34 1.48	8.2 .21	.01 0	0	166 2.72	11 .23	2.8 .08	<.01 0	.60	.26	230	100	46
Watercress[b]	2/16/82	--	2.0	7.70	137	11 .55	33 2.71	2.8 .12	3.1 .08	.03 0	0	169 2.77	9 .19	0.35 .01	<.01 0	.16	<.02	130	165	6
Willow 2[b]	2/16/82	--	7.0	7.80	334	27 1.35	24 1.97	4.3 .19	2.9 .07	.01 0	0	169 2.77	11 .23	0.35 .01	<.01 0	.18	<02	230	165	7

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
Willow 7[b]	2/16/82	--	9.0	7.85	251	33 1.65	7.1 .58	4.9 .21	3.2 .08	.01 0	0	115 1.89	13 .27	2.3 .06	<.01 0	.14	<.02	180	112	10
Willow[b] dnstr from source	2/16/82	--	8.0	7.74	310	50 2.50	6.6 .54	4.5 .20	2.6 .07	.01 0	0	156 2.56	9 .19	2.1 .06	.13 .02	.17	<0.2	210	152	7
L.V.Creek[b] Delta	2/17/82	--	6.0	8.20	337	29 1.45	9.8 .81	16 .70	16 .41	<.01 0	0	71 1.16	86 1.79	7.1 .2	0.4 .06	.13	<0.2	230	112	23
L.V.Delta 2[b]	2/17/82	--	11.0	7.7	193	23 1.15	3.5 .29	8.6 .37	2.2 .06	<.01 0	0	85 1.39	8 .17	1.4 .04	2.6 .37	<0.1	<0.2	140	72	23
So.Tufa[b] Hot	2/17/82	--	35.0	6.57	2640	124 6.19	73 6.0	427 18.57	3.8 .10	.01 0	0	1500 24.6	30 .62	103 2.9	.14 .02	.37	7.8	1780	610	68
Deep Hot[b] So. Tufa	2/17/82	--	33.0	6.9	3030	108 5.39	79 6.5	493 21.43	4.6 .12	.01 0	0	1550 25.41	34 .71	117 3.3	.18 .03	.85	8.9	2170	592	72
Sandpiper[b]	7/14/82	70	27.0	9.6	4210	12 0.6	0.1 .01	970 42	70 1.8	.01 0	980 33	350 5.7	280 5.8	440 12	2.4 .03	6.6	17	3300	28	92
Tioga[b] Lodge	7/14/82	--	15.0	7.8	1400	11 0.5	30 2.4	280 12	29 0.7	.02 0	10 0.3	685 11	4 .08	64 1.8	8.7 .14	1.1	1.9	910	150	80
Pebble[b]	7/14/82	--	18.0	7.1	1780	30 1.5	53 4.4	310 14	21 0.5	.04 0	20 0.7	835 14	2 .04	110 3.2	8.7 0.1	0.9	3.4	1140	295	74
Bug Warm[b]	7/14/82	--	33.0	6.5	3250	84 4.2	100 8.5	580 25	58 1.5	.01 0	20 0.7	1580 26	54 1.1	210 5.9	1.0 .01	1.1	5.2	2170	635	71
Crooked[b]	7/14/82	50	25.0	8.6	1060	26 1.3	27 2.2	180 7.7	20 0.5	.02 0	65 2.2	510 8.4	15 0.3	9.9 0.3	0.1 .01	1.7	1.6	1040	180	71
VJ[b]	7/15/82	--	16.0	8.5	875	6.0 0.3	4.2 0.3	190 8.2	24 0.6	.04 0	48 1.6	360 5.9	10 0.2	28 0.8	.07 .01	1.2	1.4	580	32	84
B'wana[b]	7/15/82	--	18.0	9.1	1470	2.4 0.1	4.4 0.4	340 15	40 1.0	0.1 .01	210 7.0	500 8.2	14 0.3	55 1.5	1.5 .02	1.6	2.3	1000	24	88
Abalos[b]	7/13/82	60	13.0	7.5	620	59 3.0	30 2.5	37 1.6	4.0 0.1	.01 0	10 0.3	345 5.7	4 .08	11 0.3	0.3 0	0.9	0.4	430	270	28
No[b] Name	7/13/82	--	13.0	7.6	250	23 1.2	10 0.8	22 1.0	21 .05	.01 0	10 0.3	130 2.1	4 .08	5.7 0.2	2.6 .04	0.2	0.2	170	100	39

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	Cl	No_3					
Warm Spg[b] Mrsh Chnl	8/25/82	30	27.0	8.2	3940	44 2.2	130 10	860 37	98 2.5	.06 0	25 0.8	2000 33	120 2.5	330 9.4	1.2 .02	18	10	2800	630	76
So Cmlt[b] Hot	8/25/82	30	55.0	6.5	2700	110 5.6	51 4.2	430 19	52 1.3	.01 0	25 0.8	1310 21	40 0.8	88 2.5	0.2 .01	0.5	6.0	1700	490	67
Shrimp[b] Farm	8/25/82	220	26.0	8.0	240	19 1.0	2.0 0.2	16 0.7	4.2 .11	.02 0	2 .07	70 1.1	16 0.3	1.4 .04	0.1 0	0.2	.09	130	56	39
Frac[b] Rock 2	8/26/82	190	19.0	9.6	390	1.6 .08	1.0 .08	76 3.3	12 0.3	.02 0	50 1.7	103 1.7	22 0.4	7.8 0.2	0.8 .01	0.3	0.3	284	8	84
Frac[b] Rock 9	8/26/82	45	20.0	8.3	670	40 2.0	12 1.0	97 4.2	22 0.6	.03 0	5 0.2	322 3	23 0.5	15 0.4	33 0.5	1.0	1.2	520	148	57
Bablyon[b] TT	9/08/82	290	25.0	7.5	200	24 1.2	4.6 0.4	8.0 0.4	1.8 .05	.01 0	5 0.2	81 1.3	8 0.2	1.8 .05	2.6 .04	0.1	.03	130	79	21
Noles[b]	9/08/82	--	24.0	7.4	180	28 1.4	2.9 0.2	3.0 0.1	0.9 .02	.02 0	5 0.2	63 1.0	22 0.5	1.8 .05	0.2 0	0.1	.01	130	82	9
Teal[b]	2/15/84	0.6	11.7	7.15	470	34 1.70	20 1.64	34 1.48	3.3 .08	<.01 0	--	230 3.77	8.0 .17	5.0 .14	1.3 .19	.25	0.3	324	168	37
Rock[b]	10/2/85	--	10.0	7.45	129	17 .85	2.7 .22	6.0 .26	1.8 .05	.01 0	--	59 0.97	6.5 .14	2.1 .06	.82 .12	0.1	.03	172	53	22
Persvrnce[b]	10/3/85	25	25.0	7.87	1670	11 .55	16 1.32	370 16.09	27 .69	.06 0	--	632 10.36	2.9 .06	207 5.84	0.5 .07	2.4	1.5	1208	92	87
Villette[b]	8/18/86	458	9.0	7.60	120	15.0 .75	1.8 .15	4.2 .18	1.5 .04	--	0	48 .79	8.5 .18	1.8 .05	0.2 .03	0.1	.05	90	46	19
Co.Pk 1[b]	8/18/86	323	12.0	7.75	380	64.0 3.19	13.0 1.07	5.7 .25	2.4 .06	.01 0	0	205 3.38	3.7 .08	0.7 .02	--	0.2	.06	240	193	07
Co.Pk 2[b] W.Fork 1	8/18/86	628	10.0	7.69	260	38.0 1.9	4.9 .40	5.1 .22	2.5 .06	--	0	128 2.11	4.0 .08	0.4 .01	--	.14	.05	152	116	10
Spyglass[b]	8/19/86	31	10.0	8.65	220	7.2 .36	1.8 .15	32.0 1.39	4.7 .12	--	0	88 1.45	16.0 .33	0.7 .02	--	.14	.13	178	26	70
Gulbth Wst[b] W.Fork 1	8/19/86	319	10.0	7.87	200	17.0 .85	3.4 .30	15.0 .65	3.0 .08	--	0	81 1.34	11.0 .23	2.1 .06	0.2 .03	.10	.06	139	56	39

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in parts per Million / equivalents per million										F ppm	B ppm	TDS ppm	Total[e] Hardness as CaCO$_3$ ppm	%Na[f]
						Ca	Mg	Na	K	Fe	Co$_3$	HCo$_3$	SO$_4$	Cl	No$_3$					
Gull Bath[b] East	8/19/86	193	11.0	8.10	220	20.0 1.00	2.9 .24	17.0 .74	2.9 .07	--	0	89 1.47	13.0 .27	2.8 .08	0.1 .01	.18	.13	150	62	40
L.V.Cr[b] Delta	8/19/86	135	10.0	7.16	--	28.0 1.40	12.0 .99	30.0 1.3	3.5 .09	.03 0	0	178 2.93	9.0 .19	8.5 .24	0.2 .03	.16	.37	249	120	41
Shrimp[b] Farm	8/19/86	202	13.0	7.91	280	36.0 1.80	1.5 .12	16.0 .70	4.2 .11	--	0	125 2.06	14.0 .29	0.4 .01	--	0.2	0.1	168	99	28
Warm[b] Spgs	8/19/86	22	30.0	7.72	3000	38.0 1.90	26.0 2.14	596.0 25.91	51.0 1.30	.01 0	0	1380 22.75	62.0 1.29	227.0 6.40	1.6 .23	1.0	5.4	2104	204	84
Bug[b] Warm	8/19/86	14	32.0	6.92	2700	107.0 5.34	49.0 4.03	584.0 25.39	54.0 1.38	.02 0	0	1950 32.14	46.0 .96	43.0 1.21	0.1 .01	.89	5.3	2260	640	74
WrmSpg[b] Mrsh Chnl	8/19/86	22	20.0	8.37	4600	44.0 2.20	139.0 11.43	860.0 37.39	78.0 1.99	.07 0	0	2220 36.59	86.0 1.79	329.0 9.28	0.1 .01	.57	8.6	3040	680	77
Twin[b] Warm	8/19/86	--	32.0	6.80	3400	78.0 3.90	147.0 12.09	548.0 23.83	45.0 1.15	.02 0	0	1700 28.02	1.0 .02	185.0 5.22	0.1 .01	1.1	4.3	4517	680	67
Pebble[b]	8/19/86	--	18.0	7.24	1500	29.0 1.45	46.0 3.78	314.0 13.65	19.0 .49	.02 0	0	875 14.42	100.0 2.08	111.0 3.13	0.1 .01	.82	2.1	1150	260	77
Trinity[b]	8/19/86	31	15.0	7.74	320	32.0 1.60	31.0 2.55	50.0 2.17	7.3 .09	--	0	330 5.44	2.8 .06	2.8 .08	--	.68	.36	412	206	42
Teal[b]	8/19/86	251	11.0	6.88	520	32.0 1.60	29.0 2.38	34.0 1.48	3.5 .09	--	0	265 4.37	3.0 .06	5.0 .14	0.3 .04	.26	.28	311	200	35
Goose[b] Springs E	8/19/86	422	11.0	7.33	620	58.0 2.90	31.0 2.55	27.0 1.17	3.2 .08	--	0	340 5.60	3.0 .06	1.6 .05	--	.48	.23	400	272	23
Sand[b] Flats	8/19/86	36	11.0	6.42	350	35.0 1.75	12.0 0.99	20.0 0.87	3.5 .09	.01 0	0	190 3.13	3.5 .07	1.4 .04	0.2 .03	.18	.11	280	138	28

TABLE 12
MONO BASIN
CHEMICAL ANALYSIS OF SPRINGS

Sample Location	Sample Date	gpm Discharge	°C Temp	pH	EC X 10^6	Constituents in $\frac{\text{parts per Million}}{\text{equivalents per million}}$										F ppm	B ppm	TDS ppm	Total[e] Hardness as $CaCO_3$ ppm	% Na[b]
						Ca	Mg	Na	K	Fe	Co_3	HCo_3	SO_4	CL	No_3					
Sandpiper[b]	8/19/86	14	25.0	9.95	2600	3.2 .16	1.5 .12	540.0 23.48	37.0 .95	.01 0	0	950 15.66	109.0 2.27	156.0 4.40	.05 .01	3.9	6.5	1795	14	93
Abalos[b]	8/19/86	112	13.0	7.46	680	51.0 2.54	31.0 2.55	36.0 1.57	2.8 .07	--	0	350 5.77	2.0 .04	4.3 .12	--	.89	0.4	385	257	30
Frac[b] Rock No. 1	8/20/86	31	17.0	9.15	300	2.8 .14	1.5 .12	52.0 2.26	2.5 .06	.01 0	0	118 1.94	11.0 .23	4.3 .12	.11 .02	.22	.14	207	13	88
Frac[b] Rock No. 2	8/20/86	211	17.0	9.66	310	2.4 .12	0.7 .06	65.0 2.83	8.9 .23	--	0	151 2.49	16.0 .33	2.1 .06	.17 .02	.19	.16	262	9	84
Hot[b]	8/20/86	--	35.0	6.63	3200	104.0 5.19	101.0 8.31	474.0 20.61	45.0 1.15	.02 0	0	1700 28.02	26.0 0.54	128.0 3.61	--	0.6	5.5	2300	700	65
Charlie's[b]	8/20/86	14	10.0	7.53	130	18.0 .90	2.9 .24	5.5 .24	2.3 .06	--	0	65 1.07	6.0 .12	1.8 .05	0.7 .10	0.1	.21	108	58	19
Babylon[b] TT	8/20/86	274	11.0	7.8	240	23.0 1.15	3.9 .32	8.4 .36	2.4 .06	.02 0	0	85 1.40	6.0 .12	1.4 .04	0.5 .07	0.1	--	112	74	22
Rock[b]	8/20/86	9	11.0	7.55	180	18.0 .90	3.9 .32	5.5 .24	2.3 .06	--	0	64 1.05	5.8 .12	1.4 .04	.69 .10	0.1	.04	109	60	19

(a) Lee, Keenan, "Infrared Exploration for Shoreline Springs at mono Lake California, Test Site", Stanford RSL Technical Report 69-7, September 1969.

(b) Los Angeles Department of Water and Power records.

(c) California Departmenr of Water Resources, Southern California District, "Reconnaissance Investigation of Water Resources of Mono and Owens Basins, Mono and Inyo Counties", August 1960.

(d) Although carbonate (CO_3^{-2}) alkalinity was not measured, total alkalinity was assumed to be bicarbonate (HCO_3-)and carbonate alkalinity to be negligible for pH less than 8.

(e) Total Hardness as $CaCO_3$ = 2.5 Ca(ppm) + 4.1 Mg (ppm).

(f) $\%Na = \frac{Na}{Ca + Mg + Na + K} \times 100$ (ppm)

(g) Flow rate measured in June 1981 by DWP Hydrographer.

TABLE 13A

1974 MONO LAKE ANALYSES
(ppm)

Location	Month*	pH	Ca	Mg	Na	K	SO_4	Cl	As	SIO_2	Fe	B	PO_4	F	CO_3(a)	TDS(b)
Danburg Beach (Surface)	AUG	9.70	5.9	34	25200	1220	8830	15000	12	24	0.40	304	68	40	15540	66280
	OCT	9.68	3.3	28	29100	1460	8920	17500	16	23	0.40	315	69	46	17640	75120
Johnson Basin (Surface)	MAR	9.66	4.7	35	29000	1570	12000	17700	14	23	0.40	347	65	52	18300	79110
	MAY	9.68	3.4	30	29500	1370	10700	17500	12	24	0.40	351	78	53	18000	77620
	AUG	9.66	4.6	42	30000	1540	10600	17600	16	22	0.50	332	80	47	18420	78700
	OCT	9.67	2.8	26	30900	1540	9090	18300	17	24	0.40	314	76	48	18540	78880
Johnson Basin (120' Deep)	MAR	9.66	5.2	32	29000	1570	10300	18000	15	22	0.60	352	65	49	18360	77770
	MAY	9.69	3.8	30	29500	1370	10300	17300	13	20	0.40	328	72	53	18120	77110
	AUG	9.65	4.7	41	29300	1470	10400	17600	18	28	0.40	323	80	44	17820	77130
	OCT	9.67	2.8	26	30200	1480	9090	18100	16	30	0.40	322	77	48	18420	77810
Putnam Basin (Surface)	MAR	9.64	4.7	32	28900	1550	10500	17900	18	24	0.60	346	75	47	18240	77640
	MAY	9.68	3.8	30	29500	1370	10210	17600	13	24	0.20	332	74	53	18420	77630
	AUG	9.65	4.7	42	29500	1520	10700	17600	18	25	0.50	337	80	46	18252	78130
	OCT	9.66	3.3	30	30900	1540	9840	18300	16	24	0.50	323	76	50	18540	79640
Putnam Basin (120' Deep)	MAR	9.66	4.7	32	28900	1540	11499	17900	15	22	0.60	336	65	47	18180	78440
	MAY	9.69	2.8	30	29500	1350	10600	17200	13	22	0.60	338	69	53	18060	77140
	AUG	9.65	5.8	41	29200	1510	10400	17600	18	28	0.01	332	80	42	17952	77210
	OCT	9.67	2.8	30	31000	1500	10600	18200	18	27	0.40	315	80	51	18600	80420
East End-Central	MAR	9.65	4.7	32	28600	1530	10600	17300	15	23	0.50	352	64	45	17340	75910
	MAY	9.69	3.8	30	29500	1350	10200	17500	13	22	0.40	328	70	53	18300	77370
	AUG	9.65	4.8	43	30500	1430	9890	17800	16	22	0.40	338	84	44	18420	78590
	OCT	9.66	3.5	30	31100	1500	11000	18000	15	23	0.40	323	79	52	18240	80370
East End (90' Deep)	MAR	9.66	5.2	32	28900	1540	10700	17400	14	23	0.50	355	64	46	18240	77320
Central (70' Deep)	MAY	9.68	3.5	31	29600	1350	10600	17300	14	21	0.40	329	72	53	18180	77550
(90' Deep)	AUG	9.65	4.7	41	29400	1410	10400	17400	18	28	0.40	324	83	40	18060	77210
(90' Deep)	OCT	9.66	2.8	30	30300	1460	10200	17800	18	26	0.40	324	78	52	18300	78590
Between Paoha & Negit Island (Surface)	MAY	9.66	3.6	31	29400	1360	10200	17400	15	24	0.40	327	74	54	18250	77140
	AUG	9.64	4.7	42	30300	1450	9880	18000	16	24	0.50	333	84	40	18600	78770
	OCT	0.65	2.8	30	30900	1500	10400	17800	17	24	0.40	328	80	51	18540	79670

* Sample Date

MAR 03-15-74
MAY 05-14-74
AUG 08-27-74
OCT 10-22-74

(a) Total Alkalinity as CO_3.
(b) Total Dissolved Solids calculated as sum of ions and SIO_2.

TABLE 13B

1979 MONO LAKE ANALYSES

(ppm)

	Sample Depth (Feet)	Month	pH	Ca	Mg	Na	K	SO_4	Cl	As	SIO_2	Fe	B	PO_4	F	CO_3(a)	TDS(b)
Danburg Beach	Surface	OCT	9.99	7.4	22	7900	297	2175	4070	2.5	--	.02	89	25	11	5484	20080
Johnson Basin	Surface	MAY	9.73	7.2	41	31600	1490	10940	19800	16.0	10.0	1.60	460	70	57	19980	84470
	Surface	OCT	9.72	5.1	44	36200	1490	11143	19800	14.0	--	1.0	464	98	53	20316	89630
Johnson Basin	80	MAY	9.73	6.9	41	32600	1490	10800	20000	19.0	10.0	0.8	440	93	55	20340	85900
	120	OCT	9.70	4.9	59	35300	1480	11649	20100	7.9	--	0.8	464	79	52	20322	89520
Putnam Basin	Surface	MAY	9.73	7.3	42	31600	1490	11860	20100	18.0	9.3	0.8	460	79	56	20400	86120
	Surface	OCT	9.64	5.3	43	37100	1480	12062	19900	3.7	--	1.2	463	97	54	20592	91800
Putnam Basin	80	MAY	9.73	6.9	41	32500	1490	10780	20000	20.0	10.0	0.8	430	88	53	20340	85760
	120	OCT	9.66	4.6	42	37100	1480	11588	19900	14.0	--	1.2	482	93	54	20724	91480
East End Central	Surface	MAY	9.71	7.3	41	33400	1490	10670	20300	20.0	10.0	1.0	430	70	56	20040	86540
	Surface	OCT	9.68	4.6	42	37200	1580	12074	20100	9.8	--	0.8	482	116	54	20874	92540
East End Central	80	MAY	9.73	6.9	40	33500	1490	11400	20100	15.0	10.0	1.0	460	88	54	20220	87380
	75	OCT	9.69	4.2	43	37200	1490	12092	19800	12.0	--	0.8	511	93	54	20664	91964
Between Paoha & Negit Island	Surface	MAY	9.66	7.3	40	32500	1490	11550	19800	20.0	8.8	0.4	440	74	57	20040	85630
	Surface	OCT	9.69	4.6	37	37200	1490	13006	10300	7.0	--	0.5	501	84	50	20640	93320

* Sample Date
MAY 5-23-79
OCT ...10-17-79

(a) Total Alkalinity as CO_3
(b) Total Dissolved Solids calculated as sum of ions and SIO_2

TABLE 14

MONO LAKE WATER
TREND OF MAJOR DISSOLVED CONSTITUENTS
(ppm)

	1940	1948	1950	1953	1955	1974	1975	1976	1977	1978	1980
Sampling Date	JUNE	SEPT	SEPT	OCT	SEPT	AUG	OCT	OCT	OCT	JUL	MAR
Lake Vol. (when sampled) (Acre ft. X 10^3)	4245	4037	3825	3695	3468	2446	2348	2284	2198	2208	2136
Specific Gravity	1.041	1.044	1.047	1.048	1.0508	-	1.063	1.0747	1.0749	1.0729	1.0762
NA	17517	18640	19180	19820	21260	30500	33800	32600	31600	33600	33500
Cl	10640	11290	11920	12560	13070	17800	18500	19200	19500	20018	19600
Total Alkalinity as CO_3	12360	13951	14110	14620	13950	18420	20850	19950	20394	20100	20340
SO4	6020	6490	6720	6963	7639	9890	10400	11000	11440	11180	11200
K	1027	930	960	996	891	1430	1320	1210	1485	1400	1770
B	249	258	260	267	301	338	343	307	391	410	492
Ca	3	--	--	--	--	4.8	4.2	3.7	7.2	6.9	3.3
Mg	11	--	--	--	--	43	42	43	44	41	31
As	--	4	5	5	5	16	12	15	10	19	11
SIO2	20	22	10	13	40	22	47	7.9	5.6	23	1.1
Fe	--	--	--	--	--	0.40	0.40	0.40	0.4	0.4	0.6
PO4	42	46	44	43	50	84	86	69	73	60	54
F	--	--	--	--	--	44	52	55	51	40	56
TDS (Notes)	47930	51690	53280	55360	57250	78590	85460	84460	85000	86900	87050
Tons TDS x 10^6	287.8	296.1	290.0	291.3	283.5	---	289.9	281.7	272.9	279.8	286.4
Sample Location (Surface)	Not Avail	E.End	E.End	E.End	E.End	E.End	E.End	E.End	E.End	E.End	Paoha

Notes

1) Chemical analysis were performed by the Sanitary Engineering Division (SED) laboratory of the Los Angeles Department of Water and Power (LADWP) except for 1940 data which were determined by the Pacific Alkali Company. Original 1940 to 1955 data appear in "Mono Lake Investigation", unpublished report, by Leroy G. Black, Chemical Engineer, prepared for LADWP. Other data are from current records of SED laboratory of LADWP.

2) TDS for years 1940 to 1955 is calculated as the sum of major ions increased by a factor of 1.0025 to adjust for minor ions since data on minor ions is incomplete for those years. (Major ions for 1940 to 1955 data include Na, Cl, CO_3, SO_4, K and B). TDS for years 1974-80 is the sum of ions. All TDS data are to nearest 10 ppm.

TABLE 15

MONO BASIN
MONO LAKE CHANGE IN STORAGE

(Based on updated bathymetry work done by Pelagos in 1986)

October 1 Year	October 1 Water Surface Elevation (Ft) (1)	Surface Area (Acres) (2)	Stored Water (Ac-Ft) (3)	Change In Storage (Ac-Ft) (4)	Cumulativ Change I Storage (Ac-Ft) (5)
1912	6422.75	56,100	4,646,300	0	
1913	6422.48	56,000	4,631,200	-15,100	-15,100
1914	6424.52	56,500	4,745,800	+114,600	+99,500
1915	*6427.01	57,100	4,886,700	+140,900	+240,400
1916	6425.64	56,800	4,809,300	-77,400	+163,000
1917	6425.92	56,900	4,825,200	+15,900	+178,900
1918	6426.27	57,000	4,845,100	+199,000	+377,900
1919	6426.42	57,000	4,853,700	+8,600	+386,500
1920	6425.53	56,800	4,803,000	-50,700	+335,800
1921	6425.37	56,700	4,793,900	-9,100	+326,700
1922	6425.92	56,900	4,825,200	+31,300	+358,000
1923	6426.09	56,900	4,834,800	+9,600	+367,600
1924	6424.64	56,500	4,752,600	-82,200	+285,400
1925	6423.53	56,200	4,690,100	-62,500	+222,900
1926	6423.06	56,100	4,663,700	-26,400	+196,500
1927	6422.88	56,100	4,653,600	-10,100	+186,400
1928	6422.03	55,900	4,606,000	-47,600	+138,800
1929	6420.73	55,800	4,533,400	-72,600	+66,200
1930	6419.38	55,300	4,458,400	+75,000	+141,200
1931	6417.92	55,100	4,377,800	+80,600	+221,800
1932	6417.49	55,000	4,354,200	-23,600	+198,200
1933	6416.14	54,800	4,280,100	-74,100	+124,100
1934	6414.94	54,500	4,214,500	-65,600	+58,500
1935	6414.53	54,400	4,192,200	-22,300	+36,200
1936	6414.68	54,400	4,200,300	+8,100	+44,300
1937	6414.60	54,400	4,196,000	-4,300	+40,000
1938	6417.73	55,100	4,422,400	+226,400	+266,400
1939	6417.29	55,000	4,343,200	-79,200	+187,200
1940	6416.55	54,800	4,302,500	-40,700	+146,500
1941	6416.61	54,800	4,305,800	+3,300	+149,800
1942	6417.12	54,900	4,333,800	+28,000	177,800
1943	6417.68	55,000	4,419,600	+85,800	263,600
1944	6416.24	54,800	4,285,500	-134,100	129,500
1945	6416.79	55,000	4,315,700	+30,200	159,70
1946	6416.58	54,800	4,325,000	+9,300	169,00
1947	6415.96	54,800	4,270,200	-54,800	114,20
1948	6413.69	54,300	4,146,600	-123,600	-9,40
1949	6411.55	53,900	4,030,800	-115,800	-125,20

*October 1, 1915 value interpolated between data values of May 27, 191
and July 13, 1916.

TABLE 15 (cont.)

MONO BASIN

MONO LAKE CHANGE IN STORAGE

(Based on updated bathymetry work done by Pelagos in 1986)

October 1 Year	October 1 Water Surface Elevation (Ft) (1)	Surface Area (Acres) (2)	Stored Water (Ac-Ft) (3)	Change In Storage (Ac-Ft) (4)	Cumulative Change In Storage (Ac-Ft) (5)
1950	6409.71	53,500	3,932,000	-98,800	-224,000
1951	6407.85	53,100	3,832,900	-99,100	-323,100
1952	6408.36	53,100	3,860,100	+27,200	-295,900
1953	6407.23	53,000	3,800,100	-60,000	-355,900
1954	6404.91	52,500	3,677,700	-122,400	-478,300
1955	6402.77	52,000	3,566,000	-111,700	-590,000
1956	6401.77	52,000	3,514,200	-51,800	-641,800
1957	6400.77	51,600	3,462,500	-51,700	-693,500
1958	6401.20	51,600	3,484,700	+22,200	-671,300
1959	6399.43	51,200	3,392,900	-90,800	-762,100
1960	6397.24	50,400	3,333,300	-60,600	-822,700
1961	6395.20	49,800	3,180,400	-152,900	-975,600
1962	6393.63	49,500	3,102,400	-78,000	-1,053,600
1963	6392.39	49,000	3,041,400	-61,000	-1,114,600
1964	6390.17	48,300	2,933,100	-108,300	-1,222,900
1965	6388.69	47,900	2,862,100	-71,000	-1,293,900
1966	6387.04	47,300	2,781,700	-80,400	-1,374,300
1967	6388.35	47,600	2,845,900	+64,200	-1,310,100
1968	6386.79	47,300	2,771,800	-74,100	-1,384,200
1969	6389.12	47,900	2,882,600	+110,800	-1,273,400
1970	6387.65	47,600	2,812,500	-70,100	-1,343,500
1971	6385.77	47,000	2,723,700	-88,800	-1,432,300
1972	6383.93	45,700	2,638,700	-85,000	-1,517,300
1973	6382.41	45,100	2,569,700	-69,000	-1,586,300
1974	6380.66	44,400	2,491,200	-78,500	-1,664,800
1975	6379.02	42,700	2,419,700	-71,500	-1,736,300
1976	6377.37	42,100	2,349,700	-70,000	-1,806,300
1977	6375.22	40,700	2,260,300	-89,400	-1,895,700
1978	6374.62	40,000	2,236,200	-24,100	-1,919,800
1979	6373.07	38,000	2,175,800	-60,400	-1,980,200
1980	6373.50	38,500	2,192,400	+16,600	-1,963,600
1981	6371.94	36,500	2,134,100	-58,300	-2,021,900
1982	6372.41	36,700	2,151,400	+17,300	-2,004,600
1983	6378.22	42,400	2,385,700	+234,300	-1,770,300
1984	6379.73	43,700	2,450,200	+64,500	-1,705,800
1985	6378.34	42,500	2,390,800	-59,400	-1,765,200
1912-85	6405.01	52,500	3,682,900	-23,900	(73 yr. mean)
1941-85	6394.41	48,700	3,158,900	-42,500	(45 yr. mean)
1941-76	6399.21	50,900	3,382,600	-54,200	(36 yr. mean)
1970-85	6378.37	42,500	2,392,000	-30,700	(16 yr. mean)

TABLE 16

MONO BASIN

VALLEY FILL - WATER BALANCE*

	Historic Balance** (Average - 1941-85)	
	AF/Yr.	CFS
I. Inflow		
A. Direct Precipitation		
1. Valley Fill	155,400	214.5
2. Mono lake	31,600	43.6
B. Runoff from Hill and Mountain Areas	173,600	239.6
C. Imported Waters	3,000	4.1
D. Total Inflow	363,600	501.8
II. Outflow		
A. Exported Water	68,100	94.0
B. Consumptive Use (E-T)		
1. Mono Lake	161,200	222.5
2. Valley Fill		
a. Grant Lake	1,000	1.4
b. Irrigation E-T	7,000	9.7
c. Urban Consumptive Use	1,000	1.4
d. Native Veg. E-T	166,800	230.2
C. Total Outflow	405,100	559.2
III. Change in Storage		
A. Mono Lake	-42,500	-58.7
B. Grant Lake	+1,000	+1.4
C. Groundwater	0	0
D. Total Change in Storage	-41,500	-57.3

[illegible]lley Fill (including Mono Lake) is the free body diagram [illegible] balance.

[illegible]rage Lake size is 48,700 acres and average elevation is [illegible]94.41 feet.

TABLE 17

MONO BASIN
SURFACE AND SUBSURFACE INFLOW TO MONO LAKE

		Area and Storage*				Lake Evaporation				Lake Precipitation		
Oct. 1 Year (1)	Water Year (2)	Water Surface Elevation Feet (3)	Stored Water 1000's Ac-Ft (4)	Surface Area Ac (5)	Change In Storage Ac-Ft (6)	Index (7)	Lake Specific Gravity (8)	Evap. Adj. Ac-Ft (9)	Evap. Ac-Ft (10)	Index (11)	Precip. Ac-Ft (12)	Surface & Subsurface Inflow to Lake Ac-Ft (13)
1935	1934-35	6414.53	4192.2	54,400	-22300	1.00	1.04	.97	184,700	1.33	48,200	114,200
1936	35-36	6414.68	4200.03	54,400	+8100	1.00	1.04	.97	184,700	0.81	29,400	163,400
1937	36-37	6414.60	4196.0	54,400	-4300	1.00	1.04	.97	184,700	1.17	42,400	138,000
1938	37-38	6417.73	4422.4	55,100	+226400	1.00	1.04	.97	187,100	1.98	72,700	340,800
1939	38-39	6417.29	4343.2	55,000	-79200	1.00	1.04	.97	186,700	0.72	26,400	81,100
1940	1939-40	6416.55	4302.5	54,800	-40700	1.00	1.04	.97	186,000	0.68	24,800	120,500
1941	40-41	6416.61	4305.8	54,800	+3300	0.95	1.04	.97	176,700	1.25	45,700	134,300
1942	41-42	6417.12	4333.8	54,900	+28000	0.93	1.04	.97	173,300	0.92	33,700	167,600
1943	42-43	6417.68	4419.6	55,000	+85800	0.96	1.04	.97	179,300	0.90	33,000	232,100
1944	43-44	6416.24	4285.5	54,800	-134100	1.00	1.04	.97	186,000	0.71	25,900	26,000
1945	1944-45	6416.79	4315.7	55,000	+30200	0.86	1.04	.97	160,600	1.10	40,300	150,500
1946	45-46	6416.58	4325.0	54,800	+9300	0.92	1.04	.97	171,200	.99	36,200	144,300
1947	46-47	6415.96	4270.2	54,800	-54800	0.97	1.04	.97	180,500	0.97	35,400	90,300
1948	47-48	6413.69	4146.6	54,300	-123600	1.02	1.04	.97	188,000	0.50	18,100	46,300
1949	48-49	6411.55	4030.8	53,900	-115800	0.99	1.04	.97	181,200	0.76	27,300	38,100
1950	1949-50	6409.71	3932.0	53,500	-98800	0.90	1.04	.97	163,500	0.58	20,700	44,000
1951	50-51	6407.85	3832.9	53,100	-99100	0.97	1.04	.97	174,900	1.08	38,200	37,600
1952	51-52	6408.36	3860.1	53,100	+27200	0.88	1.04	.97	158,600	1.66	58,800	127,000
1953	52-53	6407.23	3800.1	53,000	-60000	0.83	1.04	.97	149,300	0.54	19,100	70,200
1954	53-54	6404.91	3677.7	53,500	-122400	0.97	1.05	.96	174,400	0.71	25,300	26,700

*based on updated bathymetry work done by Pelagos in 1986

(Note: indices based on historic data through 1985)

TABLE 17 (cont.)

MONO BASIN

SURFACE AND SUBSURFACE INFLOW TO MONO LAKE

		Area and Storage*				Lake Evaporation				Lake Precipitation		Surface & Subsurface Inflow to Lake Ac-Ft (13)
Oct. 1 Year (1)	Water Year (2)	Water Surface Elevation Feet (3)	Stored Water 1000's Ac-Ft (4)	Surface Area Ac (5)	Change In Storage Ac-Ft (6)	Index (7)	Lake Specific Gravity (8)	Evap. Adj. Ac-Ft (9)	Evap. Ac-Ft (10)	Index (11)	Precip. Ac-Ft (12)	
1955	1954-55	6402.77	3566.0	52,000	-111700	0.98	1.05	.96	171,200	0.73	25,300	34,200
1956	55-56	6401.77	3514.2	52,000	-51800	1.00	1.05	.96	174,700	1.49	51,700	71,200
1957	56-57	6400.77	3462.5	51,600	-51700	1.02	1.05	.96	176,800	0.87	29,900	95,200
1958	57-58	6401.20	3484.7	51,600	+22200	0.93	1.05	.96	161,200	1.34	46,100	137,300
1959	58-59	6399.43	3393.9	51,200	-90800	1.02	1.05	.96	175,500	0.79	27,000	57,700
1960	1959-60	6397.24	3333.3	50,400	-60600	1.03	1.05	.96	174,400	0.37	12,400	101,400
1961	60-61	6395.20	3180.4	49,800	-152900	0.84	1.05	.96	140,600	0.85	28,200	-40,500
1962	61-62	6393.63	3102.4	49,500	-78000	1.00	1.05	.96	166,300	1.21	39,900	48,400
1963	62-63	6392.39	3041.4	49,000	-61000	1.00	1.06	.96	164,600	1.33	43,400	60,200
1964	63-64	6390.17	2933.1	48,300	-108300	1.03	1.06	.96	167,200	0.75	24,200	34,700
1965	1964-65	6388.69	2862.1	47,900	-71000	1.10	1.06	.96	177,000	1.08	34,500	71,500
1966	65-66	6387.04	2781.7	47,300	-80400	1.14	1.06	.96	181,200	0.94	29,600	71,200
1967	66-67	6388.35	2845.9	47,600	+64200	0.97	1.06	.96	155,100	1.48	47,000	172,300
1968	67-68	6386.79	2771.8	47,300	-74100	1.11	1.06	.96	176,400	0.46	14,500	87,800
1969	68-69	6389.12	2882.6	47,900	+110800	0.92	1.06	.96	148,100	1.47	46,900	212,000
1970	1969-70	6387.65	2812.5	47,600	-70100	1.10	1.06	.96	175,900	0.74	23,500	82,300
1971	70-71	6385.77	2723.7	47,000	-88800	0.98	1.06	.96	154,800	0.75	23,500	42,500
1972	71-72	6383.93	2638.7	45,700	-85000	1.07	1.06	.96	164,300	0.86	26,200	53,100
1973	72-73	6382.41	2569.7	45,100	-69000	0.96	1.07	.95	144,000	1.04	31,300	43,700
1974	73-74	6380.66	2491.2	44,400	-78500	0.96	1.07	.95	141,700	1.13	33,400	29,800

*based on updated bathymetry work done by Pelagos in 1986

(Note: indices based on historic data through 1985)

TABLE 17 (cont.)

MONO BASIN
SURFACE AND SUBSURFACE INFLOW TO MONO LAKE

		Area and Storage*				Lake Evaporation				Lake Precipitation		Surface & Subsurface Inflow to Lake Ac-Ft
Oct. 1 Year (1)	Water Year (2)	Water Surface Elevation Feet (3)	Stored Water 1000's Ac-Ft (4)	Surface Area Ac (5)	Change In Storage Ac-Ft (6)	Index (7)	Lake Specific Gravity (8)	Evap. Adj. Ac-Ft (9)	Evap. Ac-Ft (10)	Index (11)	Precip. Ac-Ft (12)	(13)
1975	1974-75	6379.02	2419.7	42,700	-71500	0.95	1.07	.95	134,900	1.16	33,000	30,400
1976	75-76	6377.37	2349.7	42,100	-70000	0.89	1.07	.95	124,600	0.72	20,200	34,400
1977	76-77	6375.22	2260.3	40,700	-89400	1.03	1.07	.95	139,400	0.58	15,700	34,300
1978	77-78	6374.62	2236.2	40,000	-24100	0.90	1.08	.94	118,400	1.71	45,600	48,700
1979	78-79	6373.07	2175.8	38,000	-60400	1.26	1.08	.94	157,500	1.07	27,100	70,000
1980	1979-80	6373.50	2192.4	38,500	+16600	1.15	1.08	.94	145,700	1.39	35,700	126,600
1981	80-81	6371.94	2134.1	36,500	-58300	1.23	1.08	.94	147,700	0.72	17,500	71,900
1982	81-82	6372.41	2151.4	36,700	+17300	1.09	1.08	.94	131,600	1.79	43,800	105,100
1983	82-83	6378.22	2385.7	42,400	+234300	1.10	1.07	.94	153,400	1.46	41,300	346,400
1984	83-84	6379.73	2450.2	43,700	+64500	0.98	1.07	.94	140,900	0.98	28,600	176,800
1985	84-85	6378.34	2390.8	42,500	-59400	1.07	1.07	.94	149,600	0.65	18,400	71,800
1935-85 Total									8,336,100		1,667,000	4,875,400
51-Year Average		6396.93	3290.3	49,400	-36300	1.00	1.05	.96	164,000	1.00	32,700	95,600
1941-85 Total									7,252,200		1,423,100	3,917,400
45-Year Average		6394.41	3158.9	48,700	-42500	1.00	1.06	.96	161,200	.99	31,600	87,100
1941-76 Total									5,968,000		1,149,400	2,865,800
36-Year Average		6399.21	3382.6	50,900	-54200	0.98	1.05	.96	165,800	0.95	31,900	79,600
1970-85 Total									2,324,400		464,800	1,367,800
16-Year Average		6378.37	2392.0	42,500	-30700	1.05	1.07	.95	145,300	1.05	29,100	85,500

*based on updated bathymetry work done by Pelagos in 1986

(Note: indices based on historic data through 1985)

TABLE 18

MONO BASIN

MEASURED RUNOFF TOWARDS MONO LAKE EXCLUDING MILL CREEK FLOW

Values in Acre-Feet

Water Year (1)	Grant Lake Outflow (#1012) (2)	Mono Gate #1 (#1148) (3)	Flow to West Portal (2)-(3) (4)	Measured* Hill & Mtn. Runoff (5)	Runoff Towards Lake (6)= (5)-(4)
1934-35	0	0	0	125,000	125,000
35-36	0	0	0	139,300	139,300
36-37	0	0	0	124,100	124,100
37-38	0	0	0	206,200	206,200
38-39	0	0	0	103,600	103,600
39-40	0	0	0	131,300	131,300
1940-41	69,700	38,500	31,200	166,200	135,000
41-42	56,400	54,900	1,500	163,700	162,200
42-43	73,700	66,400	7,300	160,300	153,000
43-44	74,400	18,400	56,000	108,900	52,900
44-45	80,300	68,000	12,300	144,000	131,700
1945-46	64,800	64,800	0	133,000	133,000
46-47	70,500	58,100	12,400	93,700	81,300
47-48	77,500	100	77,400	96,200	18,800
48-49	93,200	0	93,200	96,800	3,600
49-50	94,100	0	94,100	96,800	2,700
1950-51	95,000	0	95,000	119,600	24,600
51-52	70,500	41,600	28,900	171,700	142,800
52-53	102,700	38,300	64,400	109,900	45,500
53-54	63,600	11,900	51,700	75,000	23,300
54-55	74,500	0	74,500	85,600	11,100
[illegible]	122,600	25,700	96,900	162,500	65,600
[illegible]	85,100	35,200	49,900	117,400	67,500
[illegible]	81,000	60,600	20,400	142,900	122,500
[illegible]	95,800	15,500	80,300	87,400	7,100
[illegible]	69,800	0	69,800	68,700	0
[illegible]	66,100	0	66,100	68,500	2,400
[illegible]	95,300	3,900	91,400	124,900	33,500
[illegible]	87,000	100	86,900	133,300	46,400
[illegible]	86,200	0	86,200	86,800	600
[illegible]	96,400	100	96,300	140,400	44,100
[illegible]	105,500	24,700	80,800	110,300	29,500
[illegible]	101,900	80,600	21,300	180,700	159,400
[illegible]	106,200	33,200	73,000	100,200	27,200
[illegible]	112,400	106,500	5,900	204,700	198,800
[illegible]	115,100	27,900	87,200	120,900	33,700

TABLE 18 (Cont.)

MONO BASIN

MEASURED RUNOFF TOWARDS MONO LAKE EXCLUDING MILL CREEK FLOW

Values in Acre-Feet

Water Year (1)	Grant Lake Outflow (#1012) (2)	Mono Gate #1 (#1148) (3)	Flow to West Portal (2)-(3) (4)	Measured* Hill & Mtn. Runoff (5)	Runoff Towards Lake (6)= (5)-(4)
1970-71	94,300	0	94,300	111,400	17,100
71-72	104,600	100	104,500	95,900	0
72-73	106,000	4,300	101,700	133,600	31,900
73-74	123,400	200	123,200	146,100	22,900
74-75	122,700	100	122,600	127,500	4,900
1975-76	76,100	100	76,000	72,500	0
76-77	45,000	0	45,000	56,100	11,100
77-78	113,200	15,100	98,100	156,700	58,600
78-79	140,800	0	140,800	129,800	0
79-80	132,700	43,500	89,200	171,300	82,100
1980-81	109,200	0	109,200	101,300	0
81-82	121,900	19,300	102,600	183,000	80,400
82-83	148,900	148,900	0	244,100	244,100
83-84	131,000	86,000	45,000	170,400	125,400
84-85	119,000	18,000	101,000	106,300	5,300
1941-85 Total	4,276,100	1,210,600	3,065,500	5,677,000	2,643,600
45-Year Mean	95,000	26,900	68,100	126,200	58,700
1941-76 Total	3,214,400	879,800	2,334,600	4,358,000	2,036,600
36-Year Mean	89,300	24,400	64,900	121,100	56,600
1970-85 Total	1,802,900	363,500	1,440,400	2,126,900	717,500
16-Year Mean	112,700	22,700	90,000	132,900	44,800

* Mono Basin Measured Hill and Mountain Runoff excluding Mill Creek Flow (see Table 3).

TABLE 19

MONO LAKE WATER BALANCE [1]

(Projected Conditions)

	WITH DIVERSIONS [3]	
	Average Lake Level 25,247 Acres at Elevation 6335 Feet	
	AF/Yr.	CFS
I. INFLOW		
A. Direct Precipitation [2]	16,800	23
B. Surface and Subsurface Inflow	53,600	74
TOTAL INFLOW	70,400	97
II. OUTFLOW		
A. Evaporation	70,400	97
III. CHANGE IN STORAGE		
A. Change in Lake Storage	0	0

[1] Shoreline of lake is the free body diagram for the water balance.

[2] Calculations based on an average precipitation of 8 inches/year.

[3] Los Angeles' Model and data. The initial (1985) lake evaporation rate is 3.3 feet with diversions for export equal to 100,000 AF/Yr. The precipitation, evaporation, and surface and subsurface runoff indexes were determined using the historic base period 1941-85. Inflow to lake is calculated as follows:

Calculated Inflow = 0.97 (Adjusted Measured Runoff - Export) + 29,800

Figures

FIGURE 1

STATE OF CALIFORNIA

GENERAL LOCATION MAP

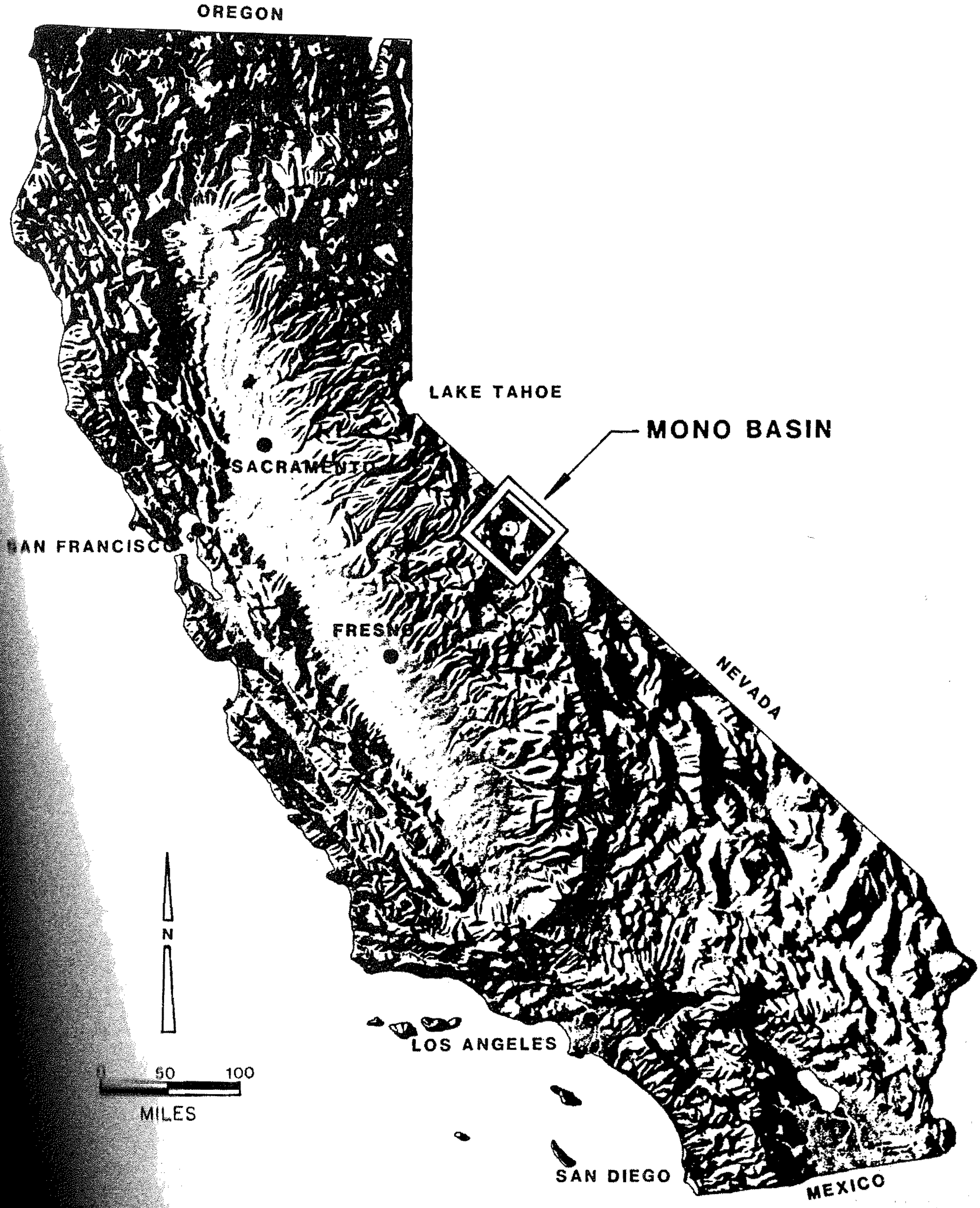
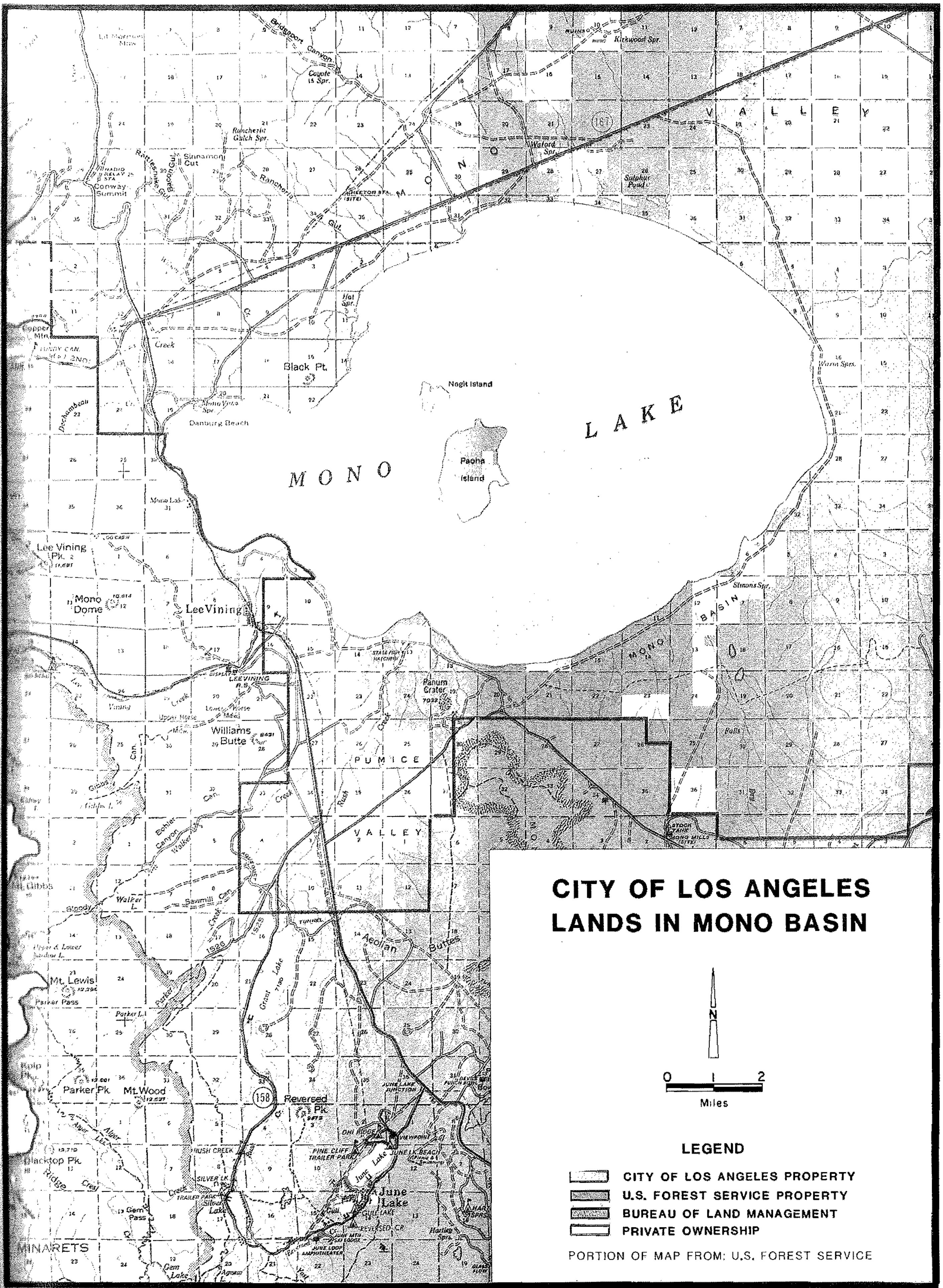


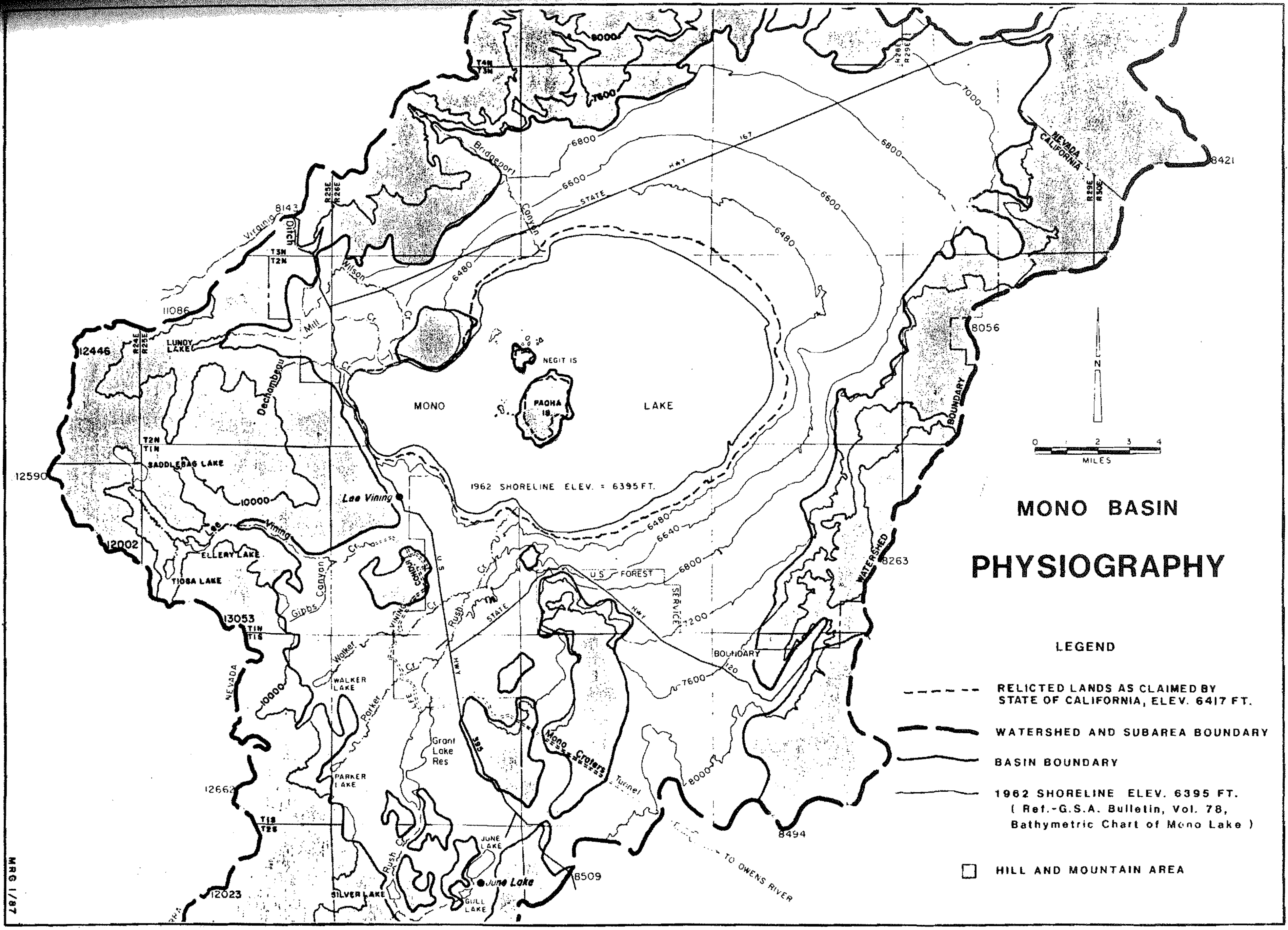
FIGURE 2



CITY OF LOS ANGELES LANDS IN MONO BASIN

PORTION OF MAP FROM: U.S. FOREST SERVICE

FIGURE 3



MONO BASIN

PHYSIOGRAPHY

FIGURE 4

MONO BASIN EXTENSION
LOS ANGELES AQUEDUCT SYSTEM

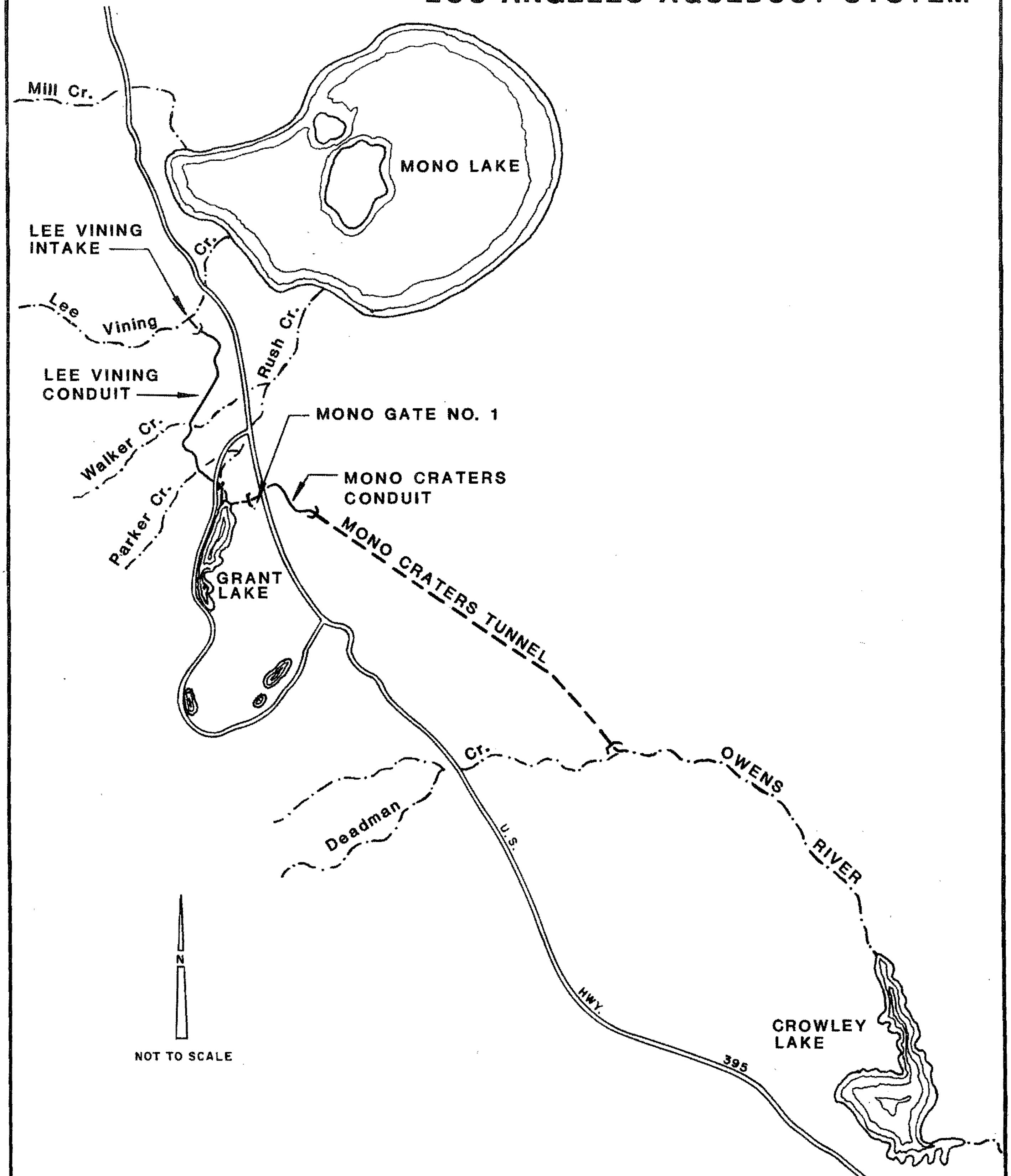


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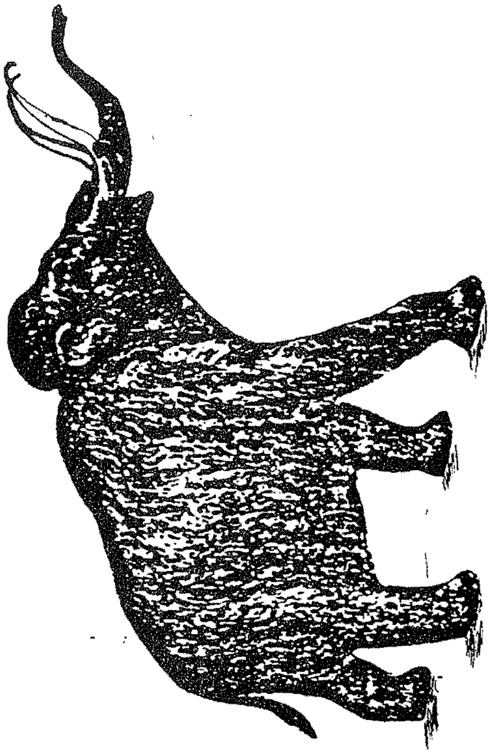
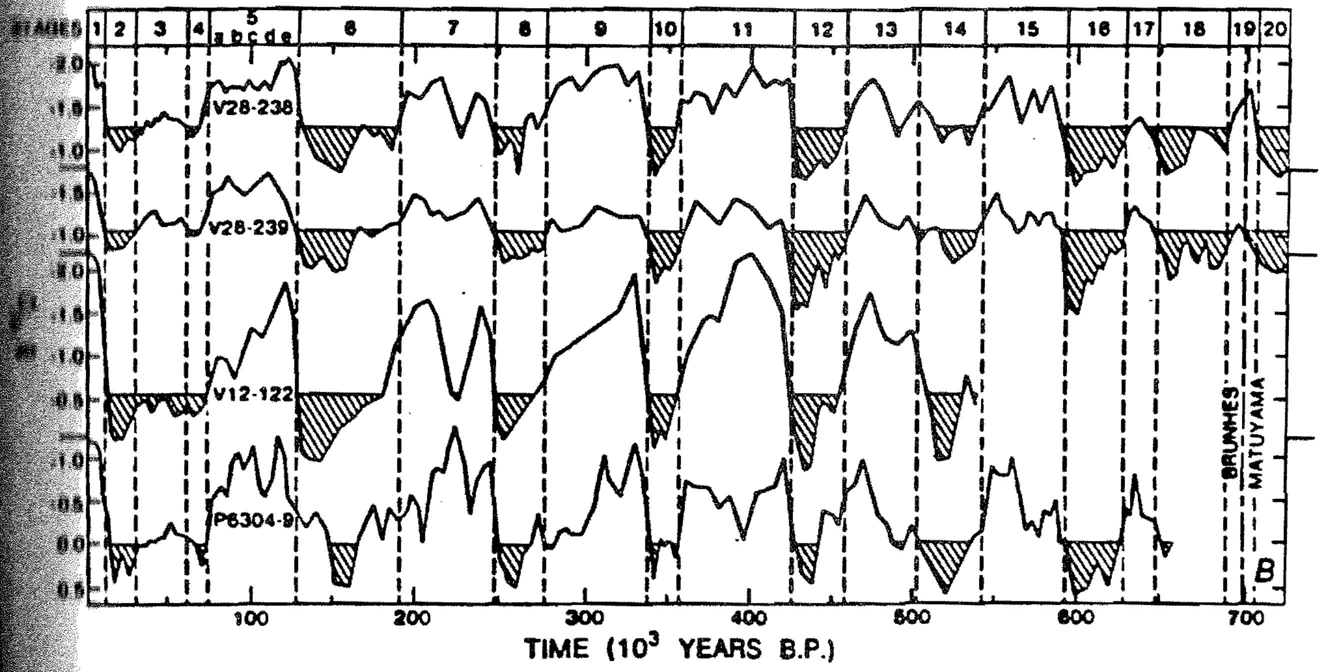
FIGURE 5

SIERRAN	MIDWEST	AGES (Ka)	REGIONAL	L. BONNEVILLE
Tioga	L. Wisconsin	13 - 32	Mono Lake high	high stand
Tenaya/Tahoe	E. Wisconsin	64 - 75	Mono Lake low	
Tahoe (?)	Illinoian	128 - 195	Long Valley Lake	high stand
Mono Basin (?)		251 - 297		
Sherwin (?)	Kansan (?)	706 - 729		
Sherwin (?)	Kansan (?)	782 - 825		
McGee	Nebraskan	1.0 - 2.2 Ma		



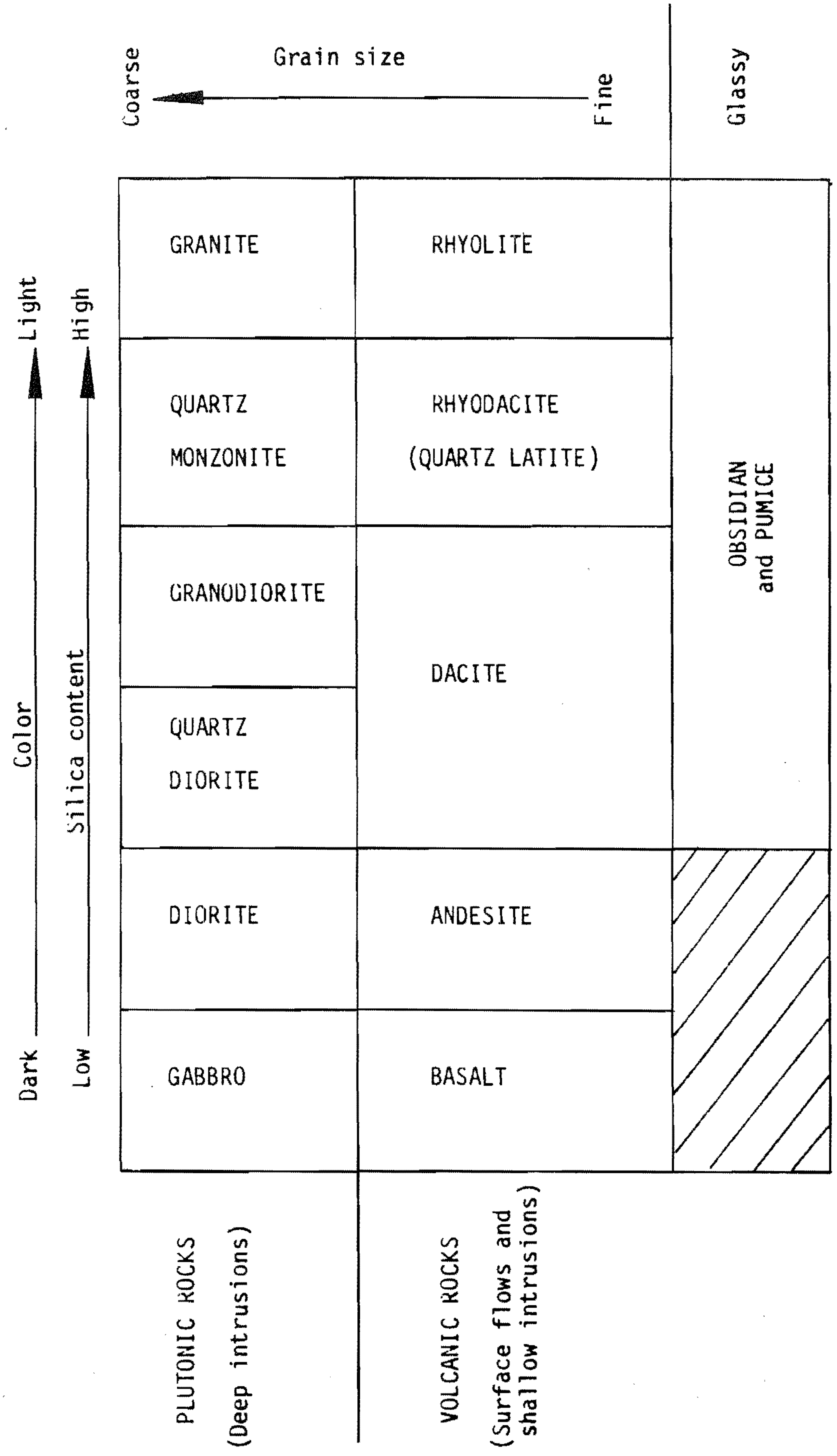


Sea Level Curves From Colman And Pierce,1981.

CORRELATION CHART OF EASTERN SIERRA NEVADA

From Gath, 1984

FIGURE 6

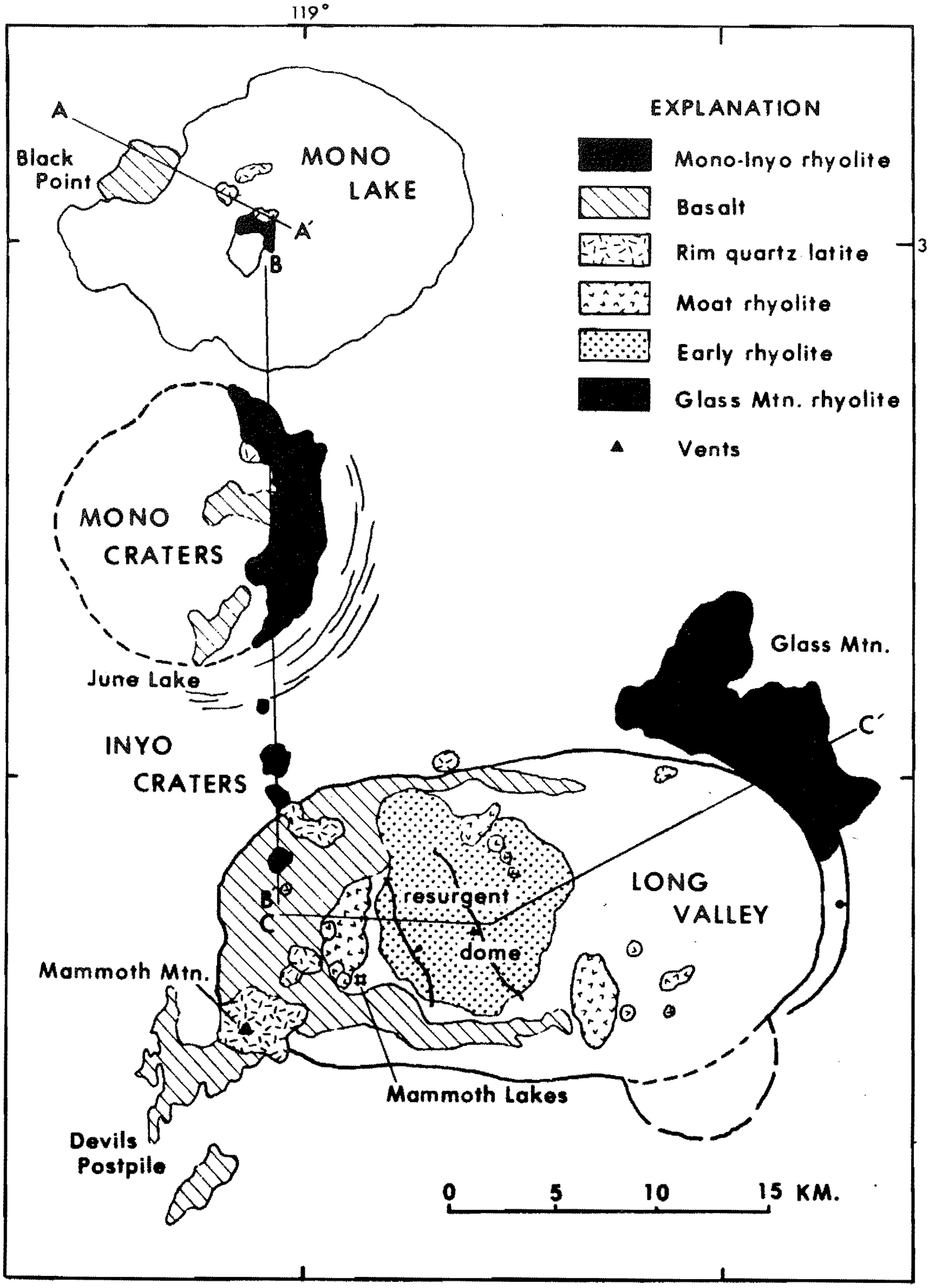


GRANITE	RHYOLITE	OBSIDIAN and PUMICE
QUARTZ MONZONITE	RHYODACITE (QUARTZ LATITE)	
GRANODIORITE	DACITE	
QUARTZ DIORITE		
DIORITE	ANDESITE	▨
GABBRO	BASALT	▨

SIMPLIFIED CLASSIFICATION CHART FOR IGNEOUS ROCKS

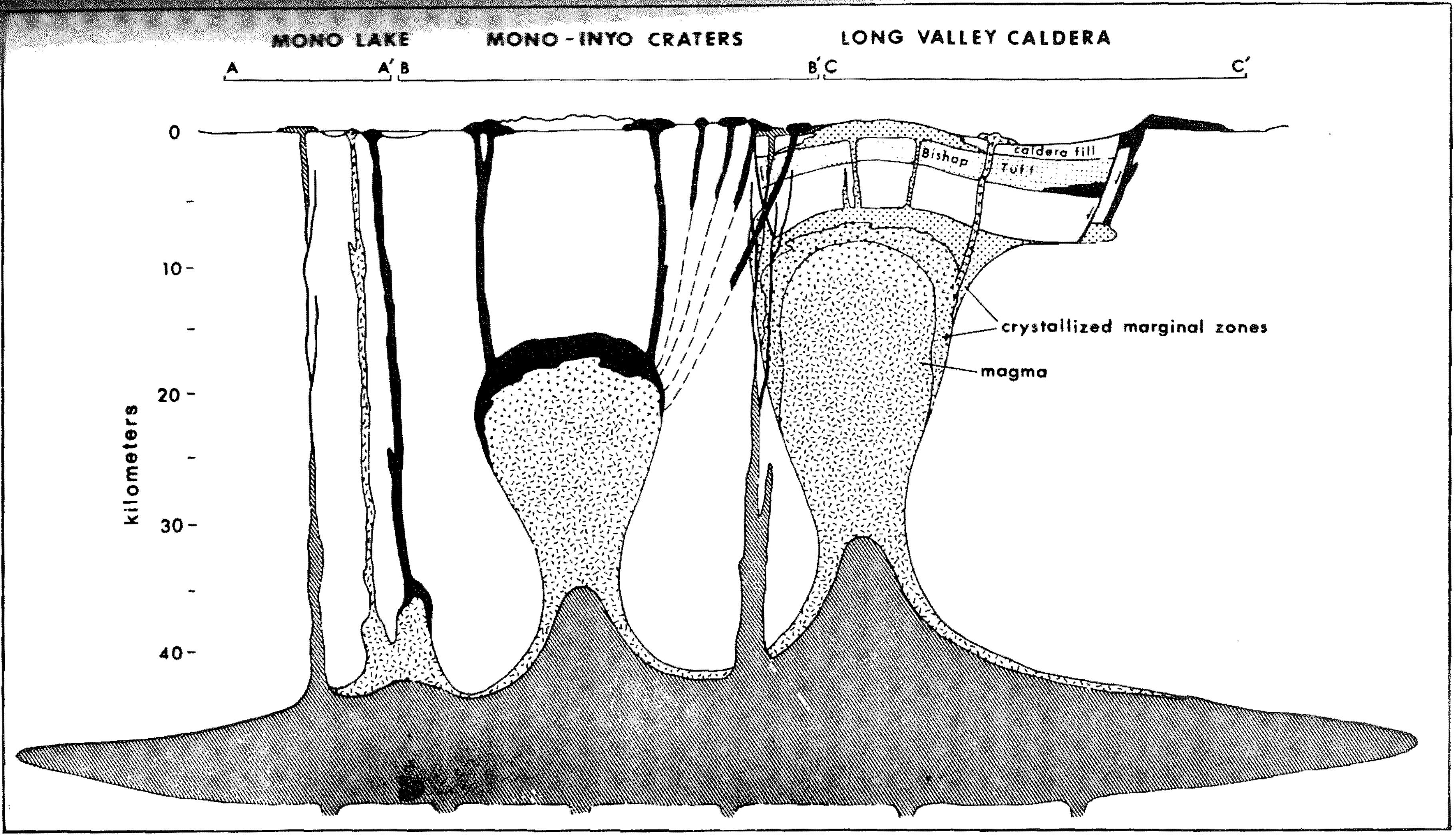
Source: Lipshie, 1979

FIGURE 7



GEOLOGIC MAP OF LONG VALLEY-MONO LAKE VOLCANIC AREA. LINES A-A′, B-B′, C-C′ SHOW APPROXIMATE LOCATION OF COMPOSITE CROSS SECTION OF FIGURE 8.

Source: Bailey, 1982



COMPOSITE SCHEMATIC CROSS SECTION OF LONG VALLEY-MONO INYO CRATERS, AND MONO LAKE VOLCANIC COMPLEXES, SHOWING HYPOTHETICAL CONFIGURATIONS OF THEIR INFERRED MAGMA CHAMBERS. SEGMENTS A-A′, B-B′, C-C′ ARE LOCATED IN FIGURE 7. ORNAMENTATION SAME AS IN FIGURE 7. VERTICAL AND HORIZONTAL SCALE APPROXIMATELY EQUAL.

Source: Bailey, 1982

FIGURE 8

FIGURE 9

MONO BASIN
DELTAIC SPRINGS

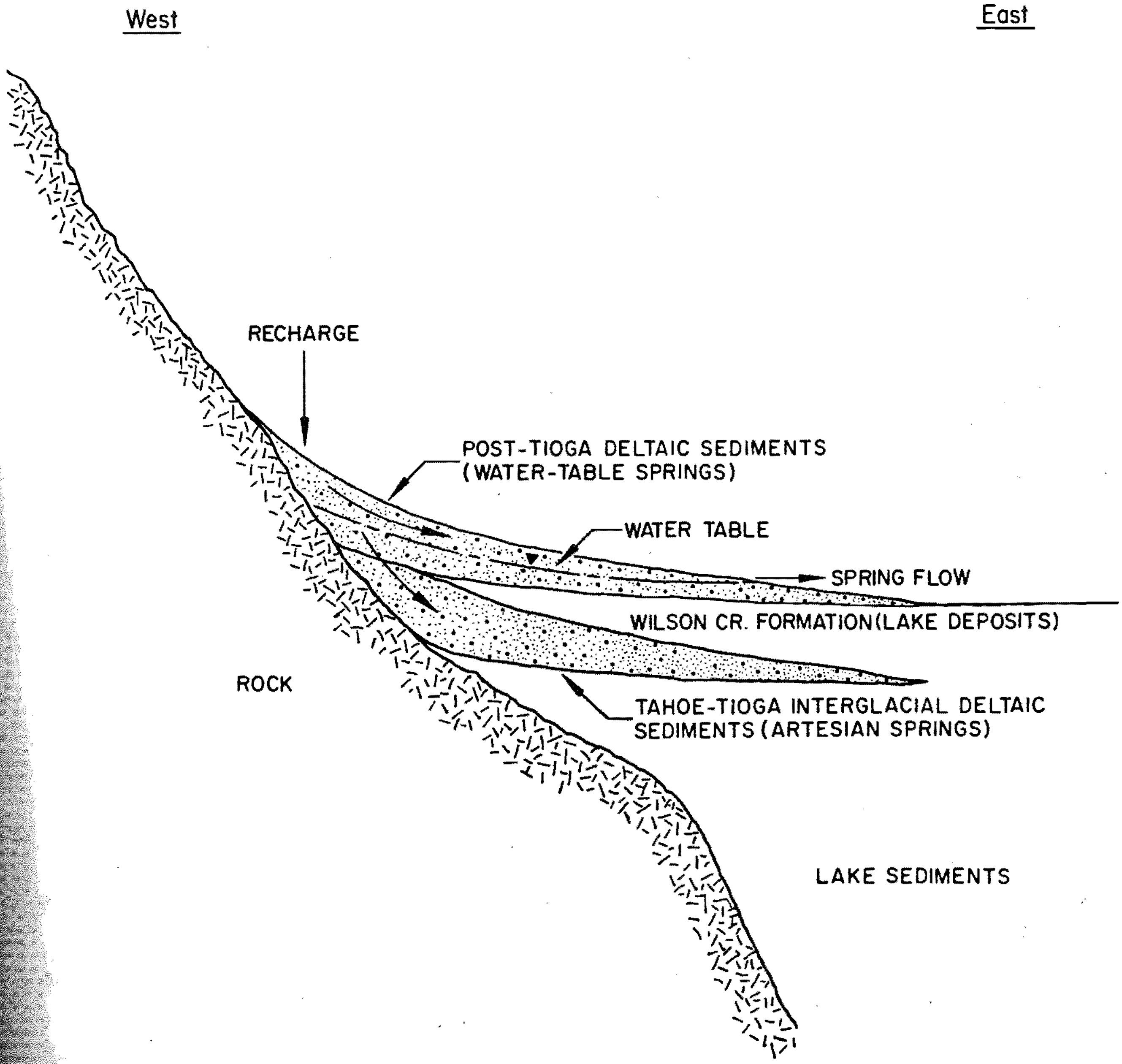


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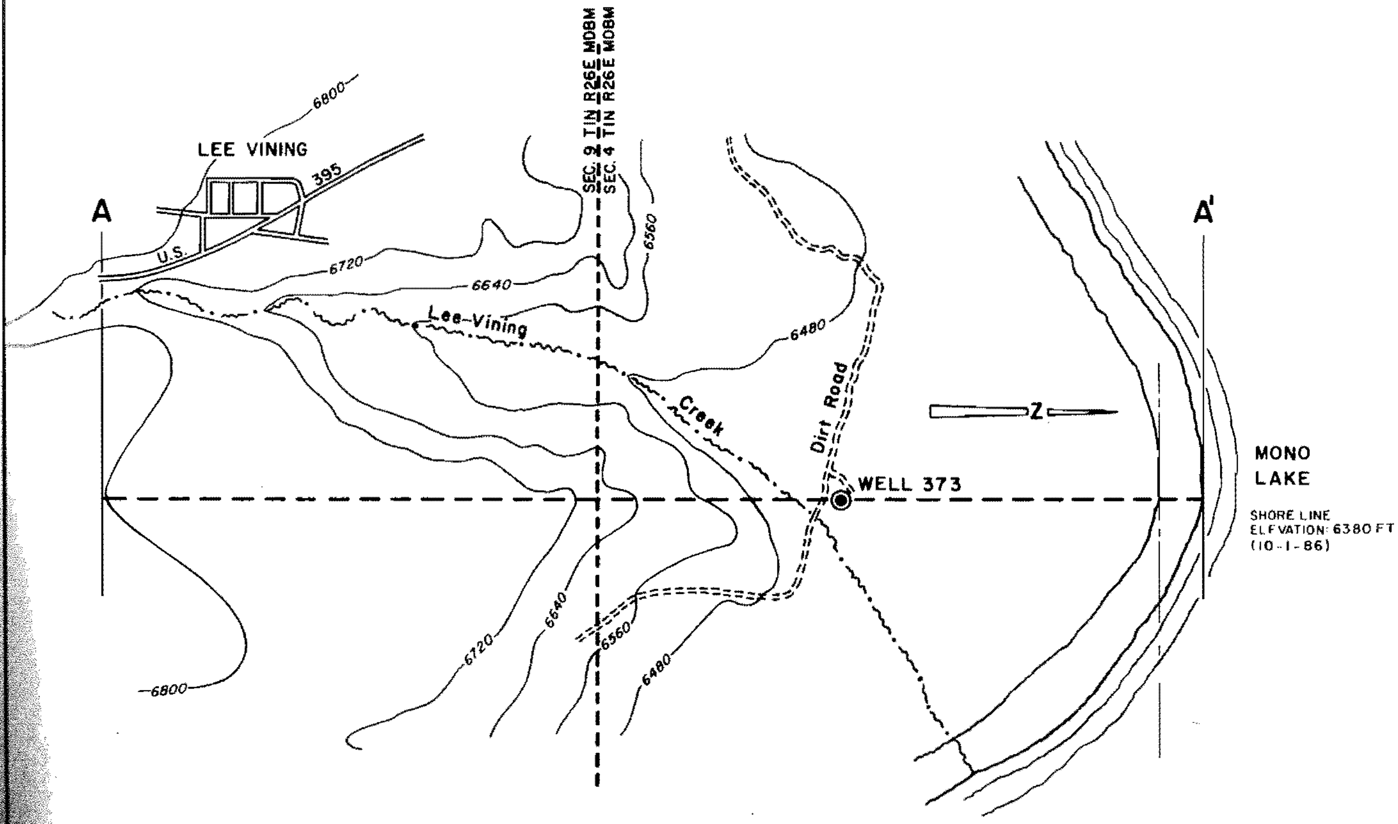
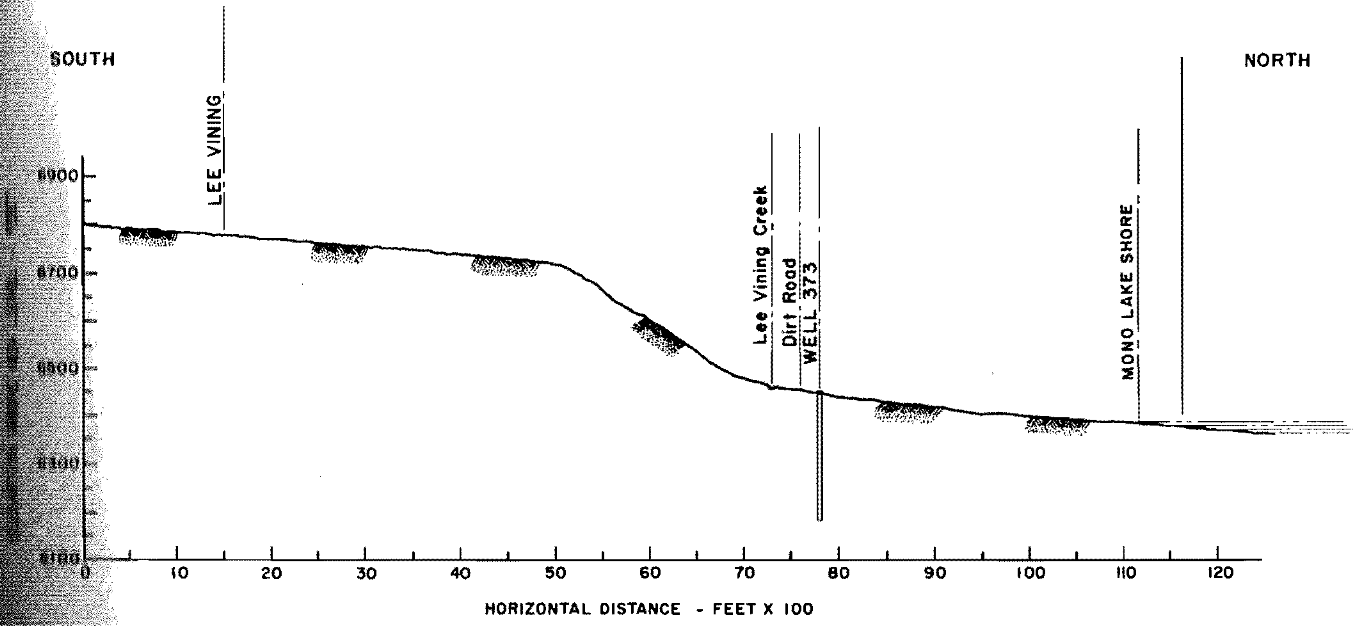
FIGURE 10

MONO BASIN

LEE VINING DELTA AREA

PROFILE A-A'

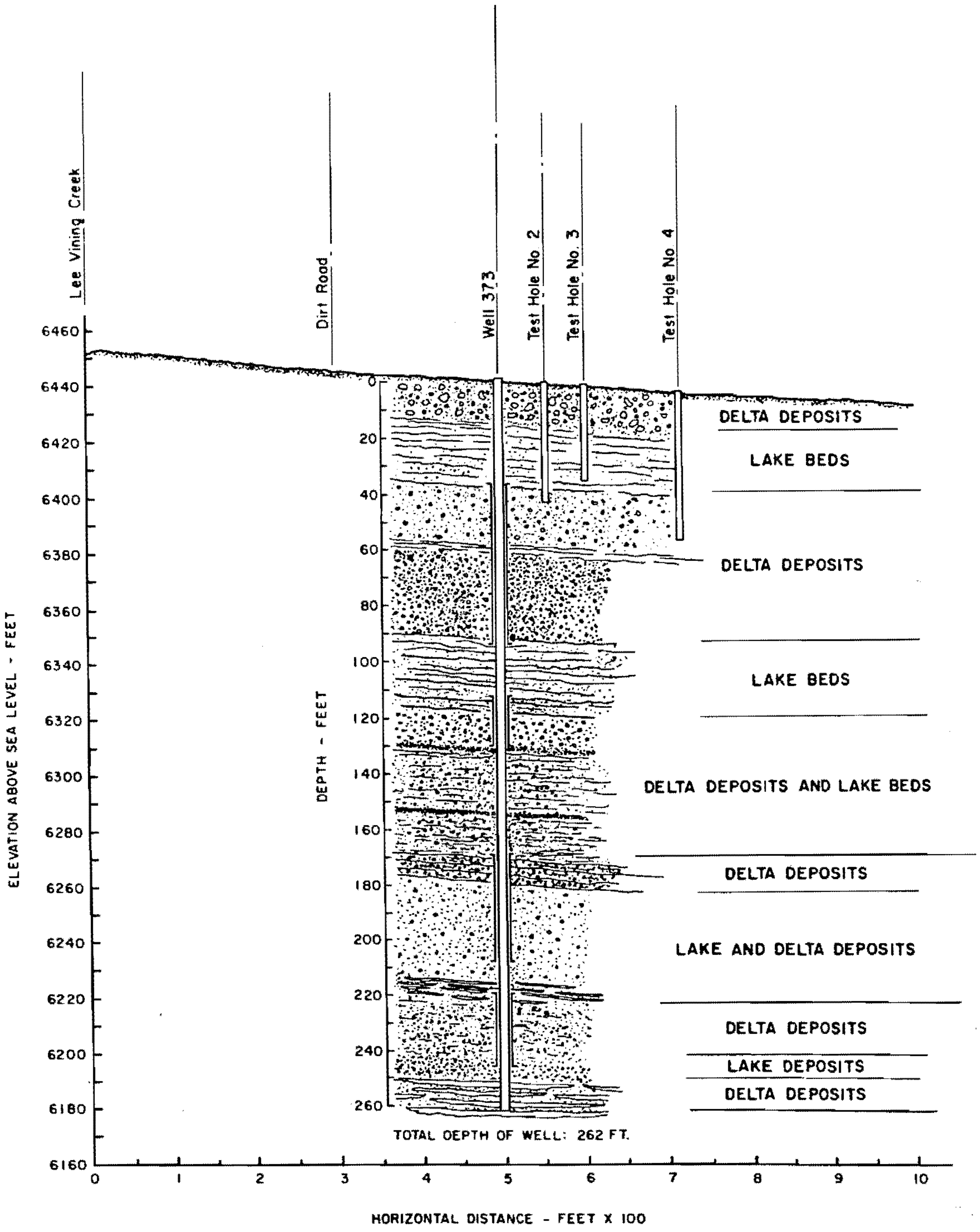




PROFILE A-A'

MRG 1/87

MONO BASIN
LEE VINING DELTA AREA
LOG OF WELL 373



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MONO BASIN
FRACTURED ROCK SPRINGS

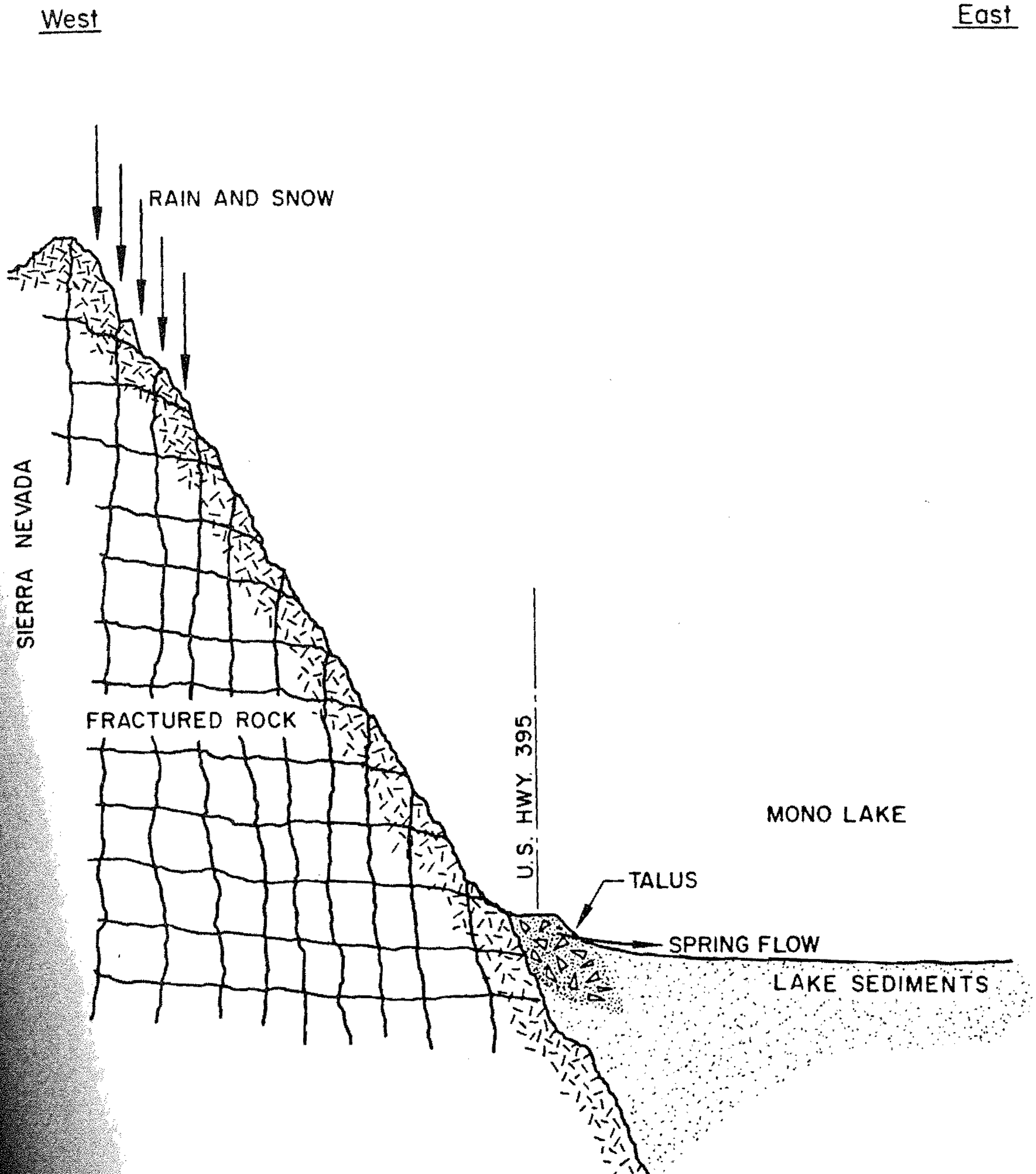

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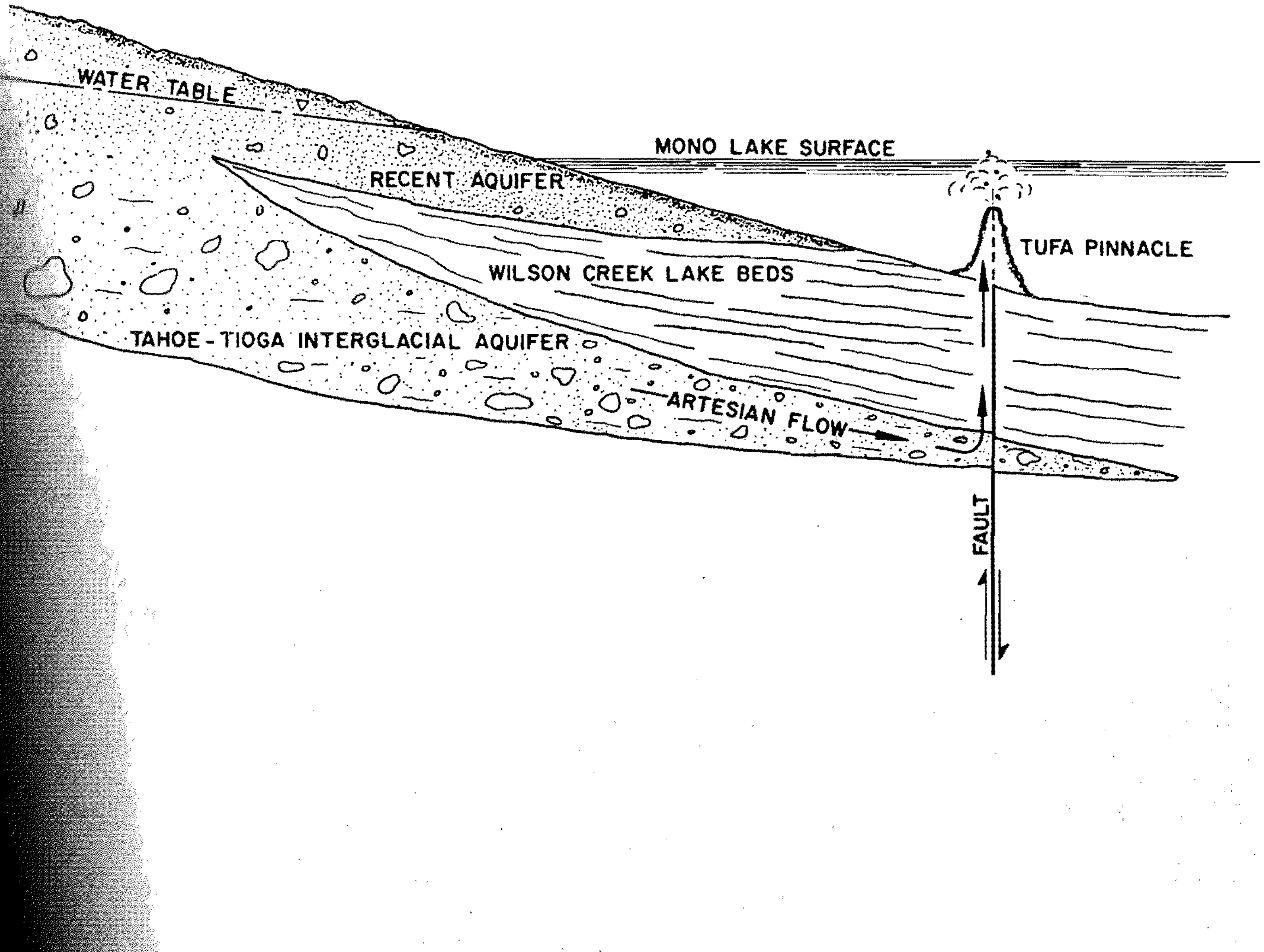
FIGURE 13

MONO BASIN
DELTAIC ARTESIAN SPRINGS



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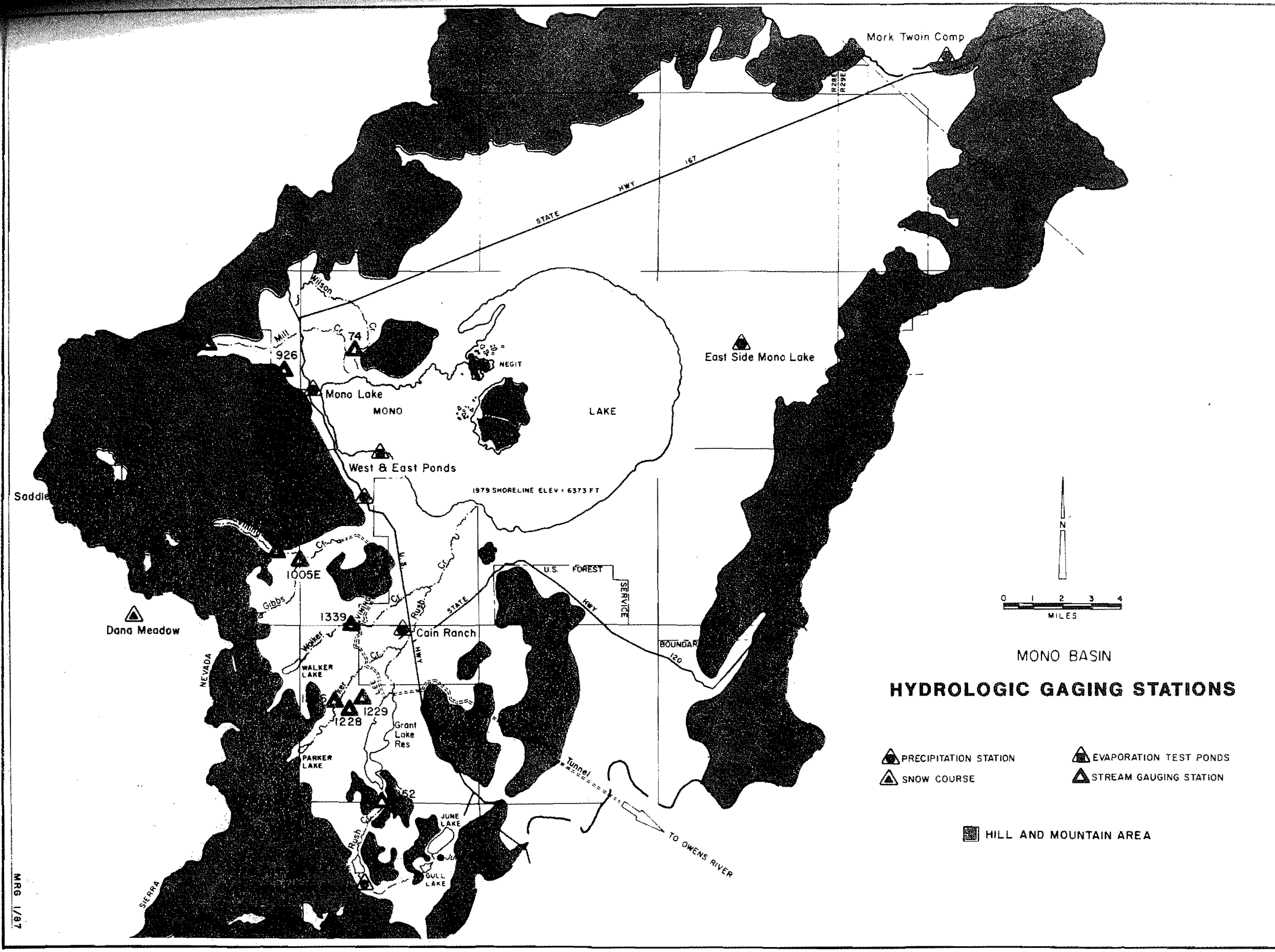
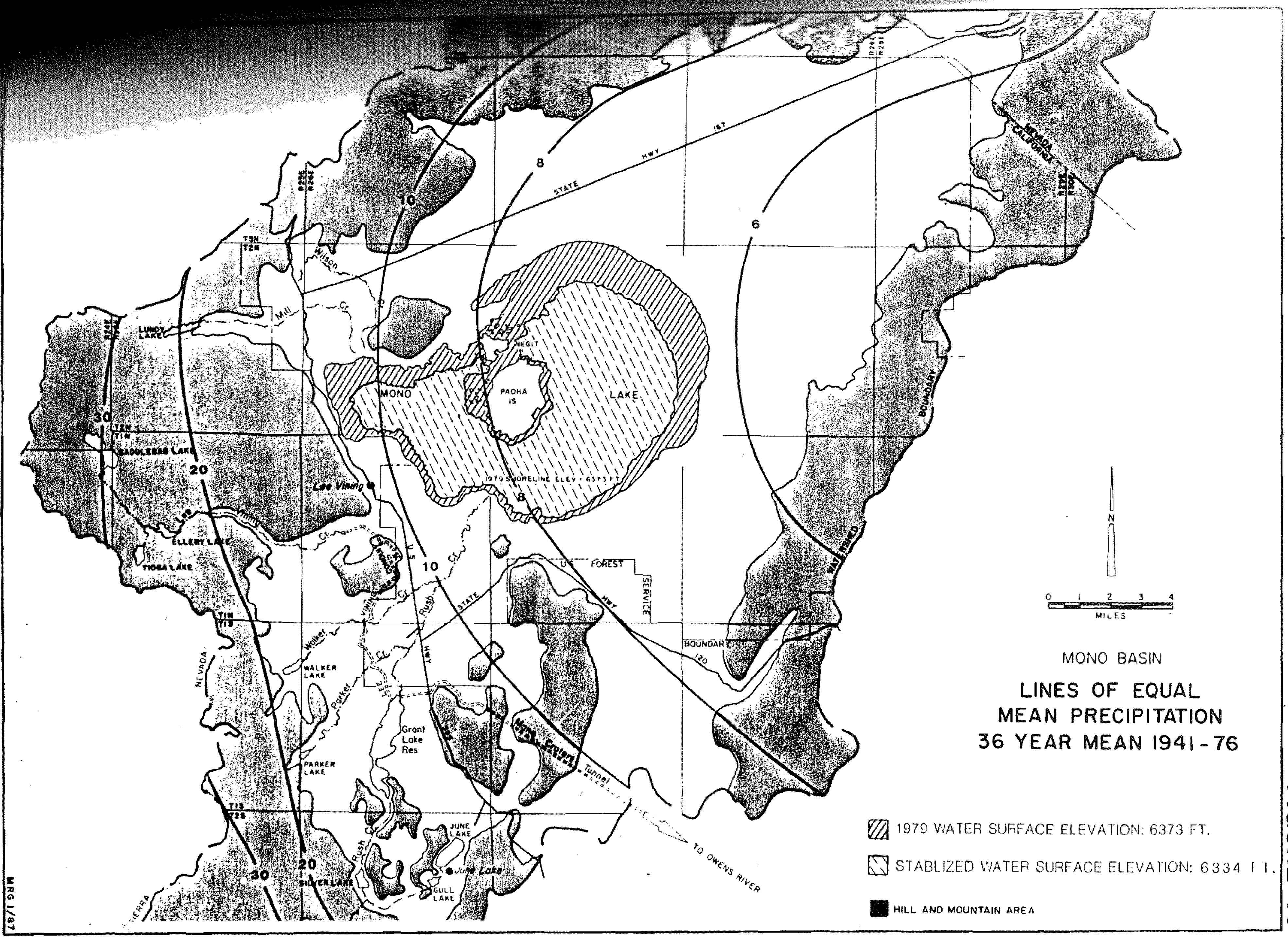


MONO BASIN

HYDROLOGIC GAGING STATIONS

FIGURE 14



MONO BASIN

LINES OF EQUAL
MEAN PRECIPITATION
36 YEAR MEAN 1941-76

▨ 1979 WATER SURFACE ELEVATION: 6373 FT.

▧ STABLIZED WATER SURFACE ELEVATION: 6334 FT.

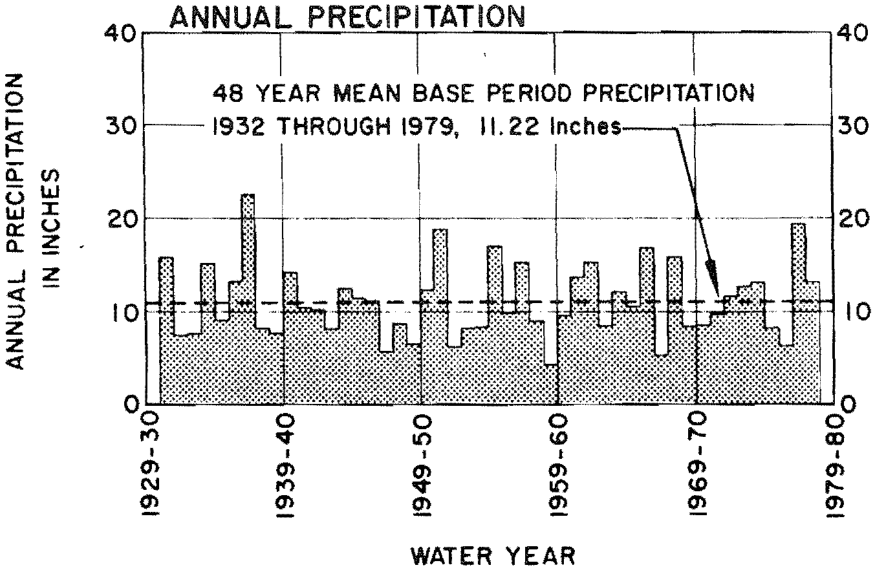
■ HILL AND MOUNTAIN AREA

FIGURE 15

FIGURE 16

CAIN RANCH PRECIPITATION
ANNUAL AND CUMULATIVE DEPARTURE
FROM LONG-TERM MEAN

ANNUAL PRECIPITATION



CUMULATIVE DEPARTURE FROM MEAN PRECIPITATION

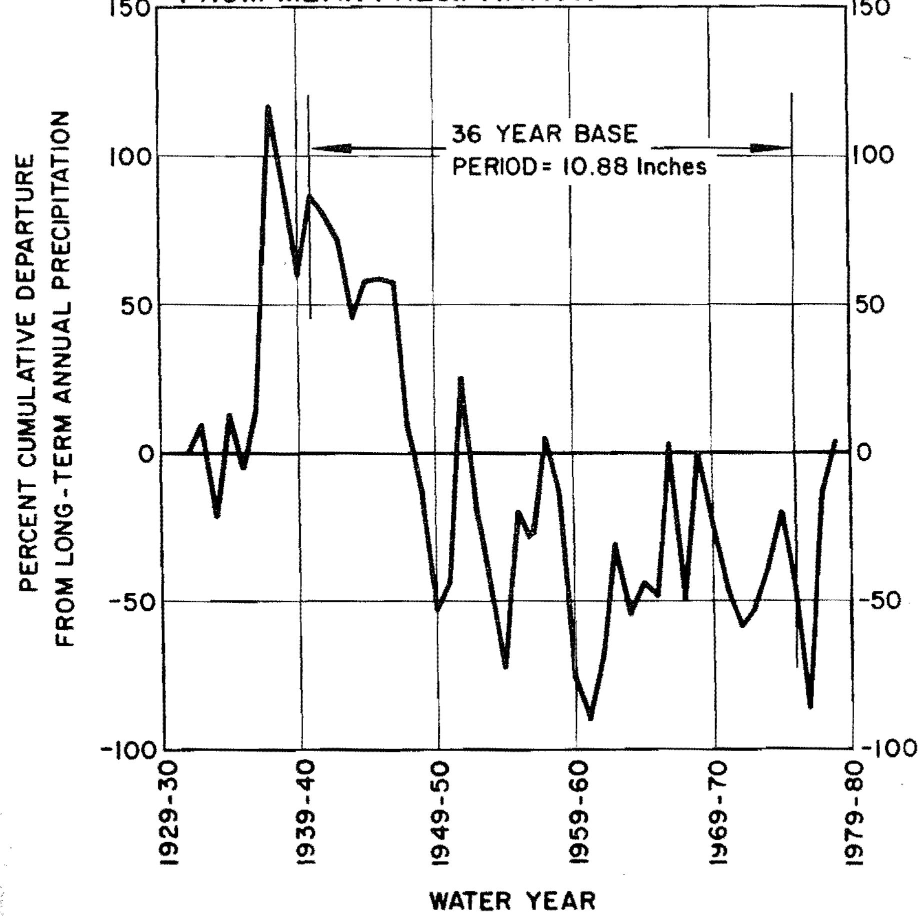


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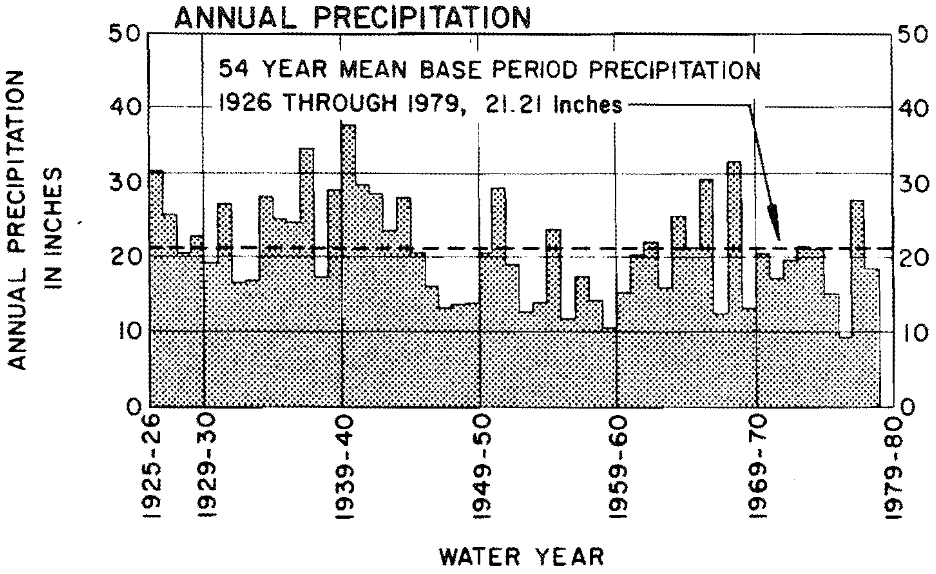
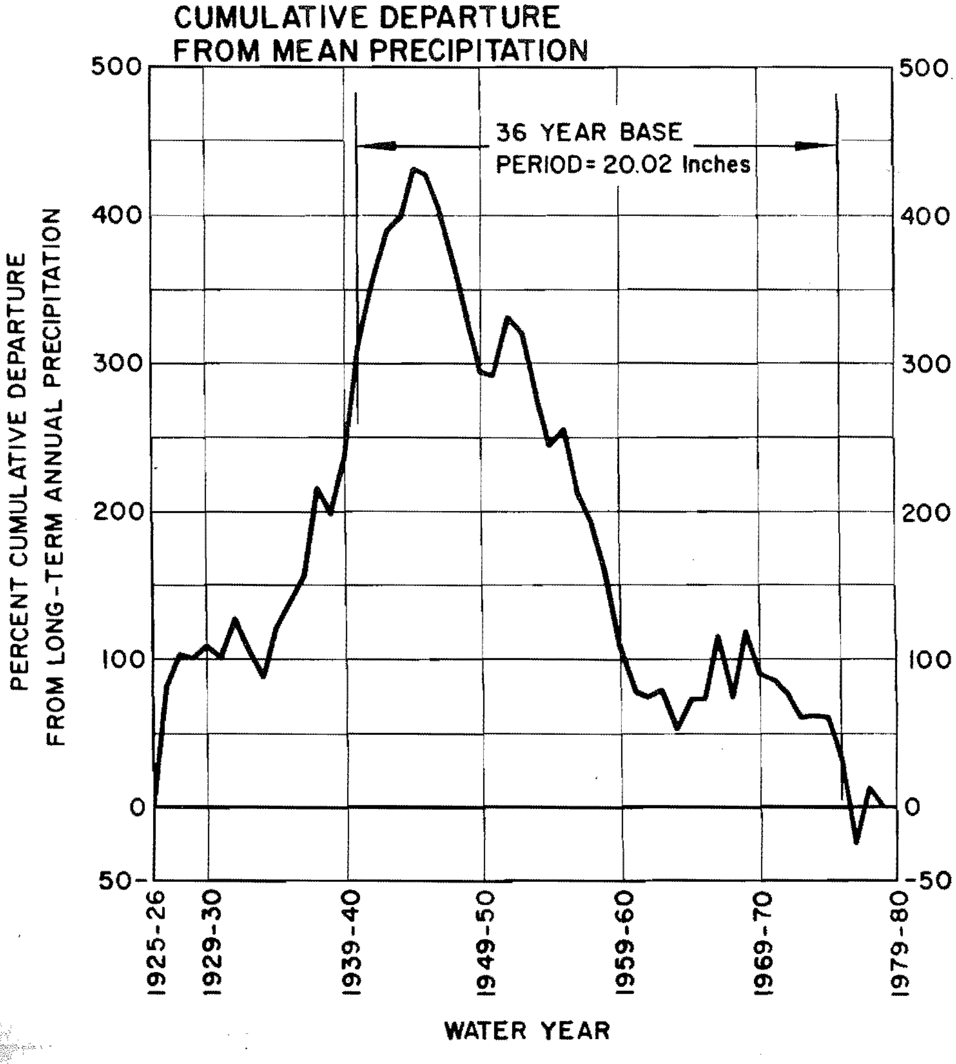
FIGURE 17

GEM LAKE PRECIPITATION
ANNUAL AND CUMULATIVE DEPARTURE
FROM LONG-TERM MEAN





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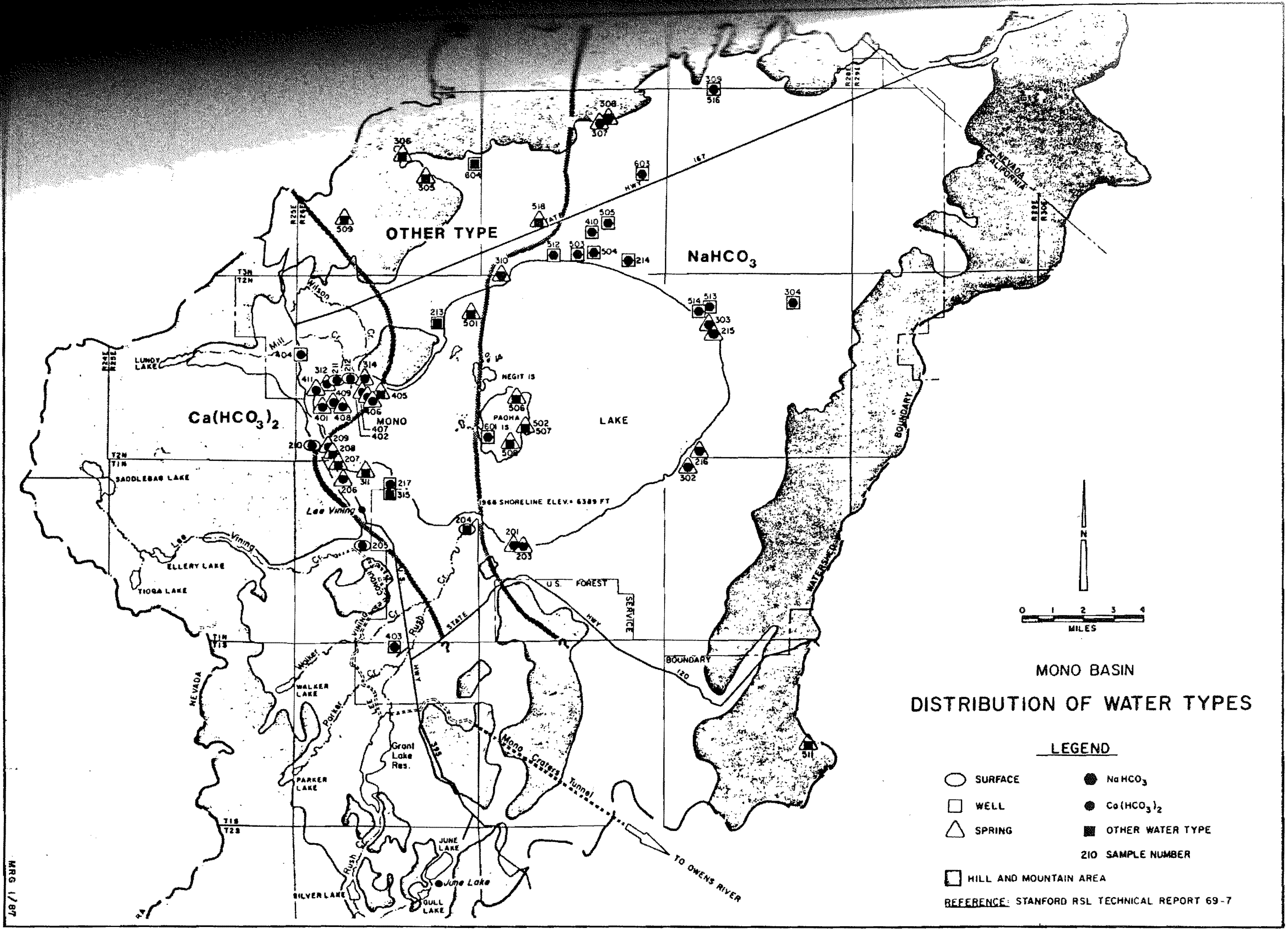
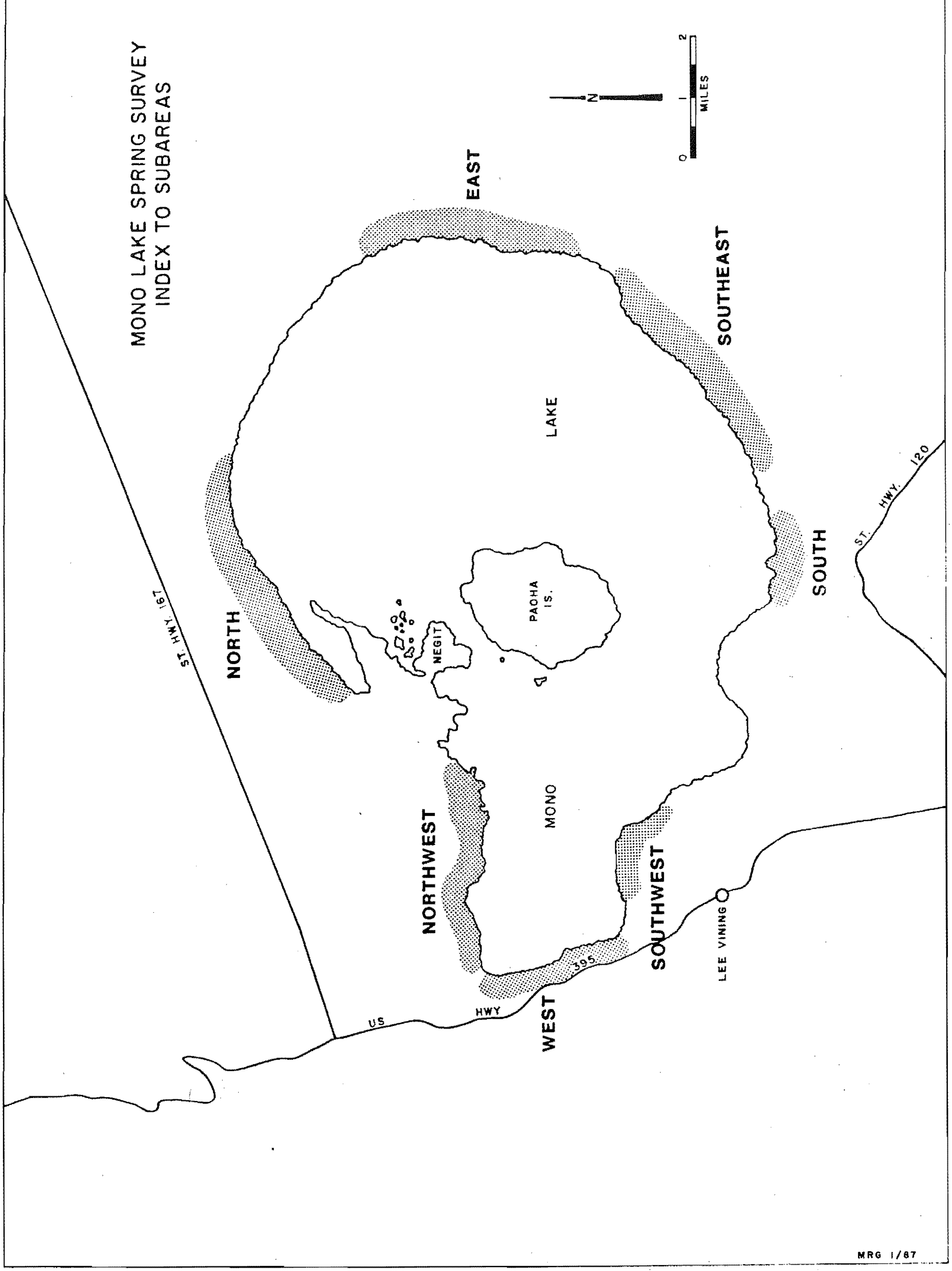


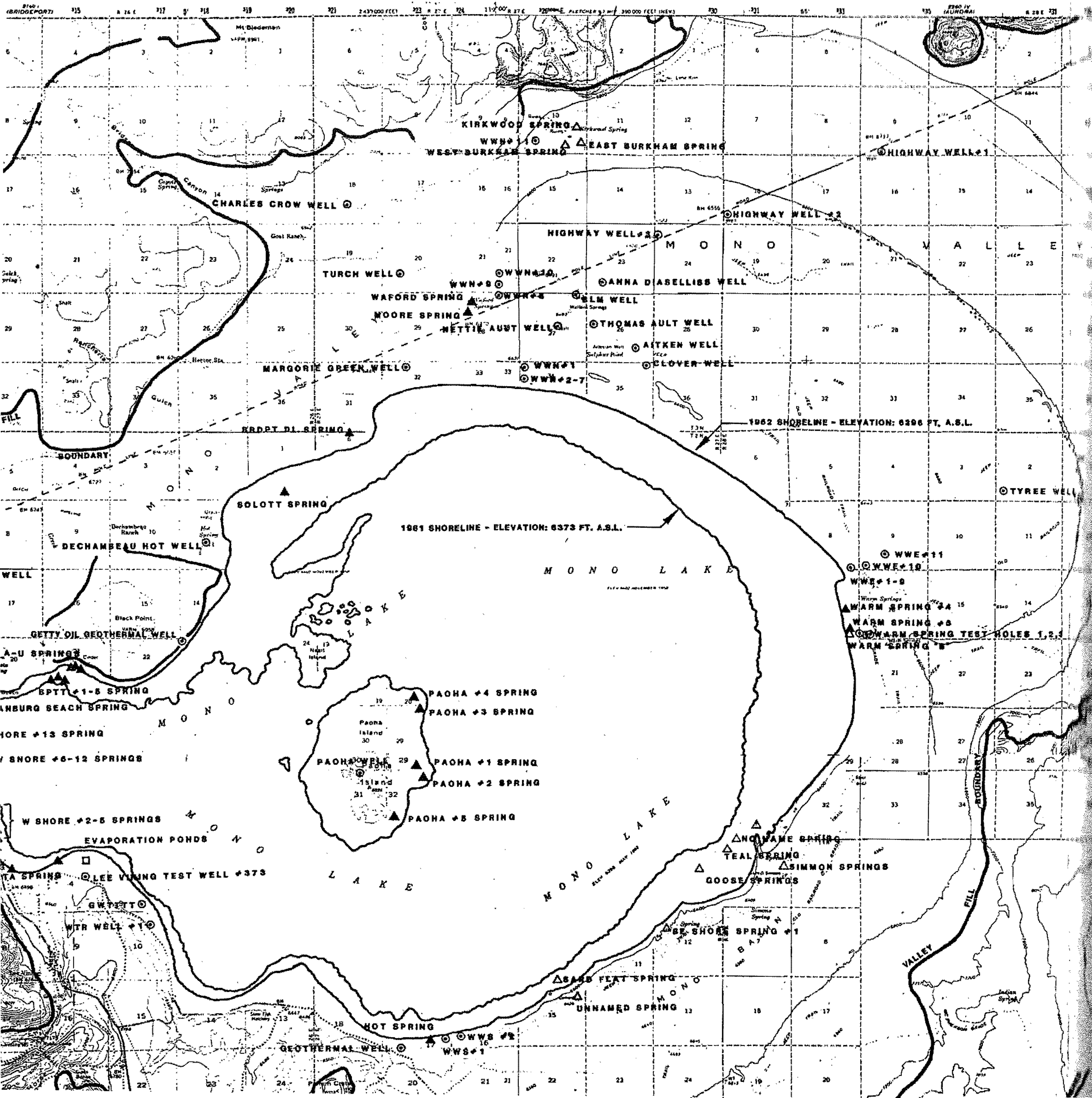
MONO BASIN

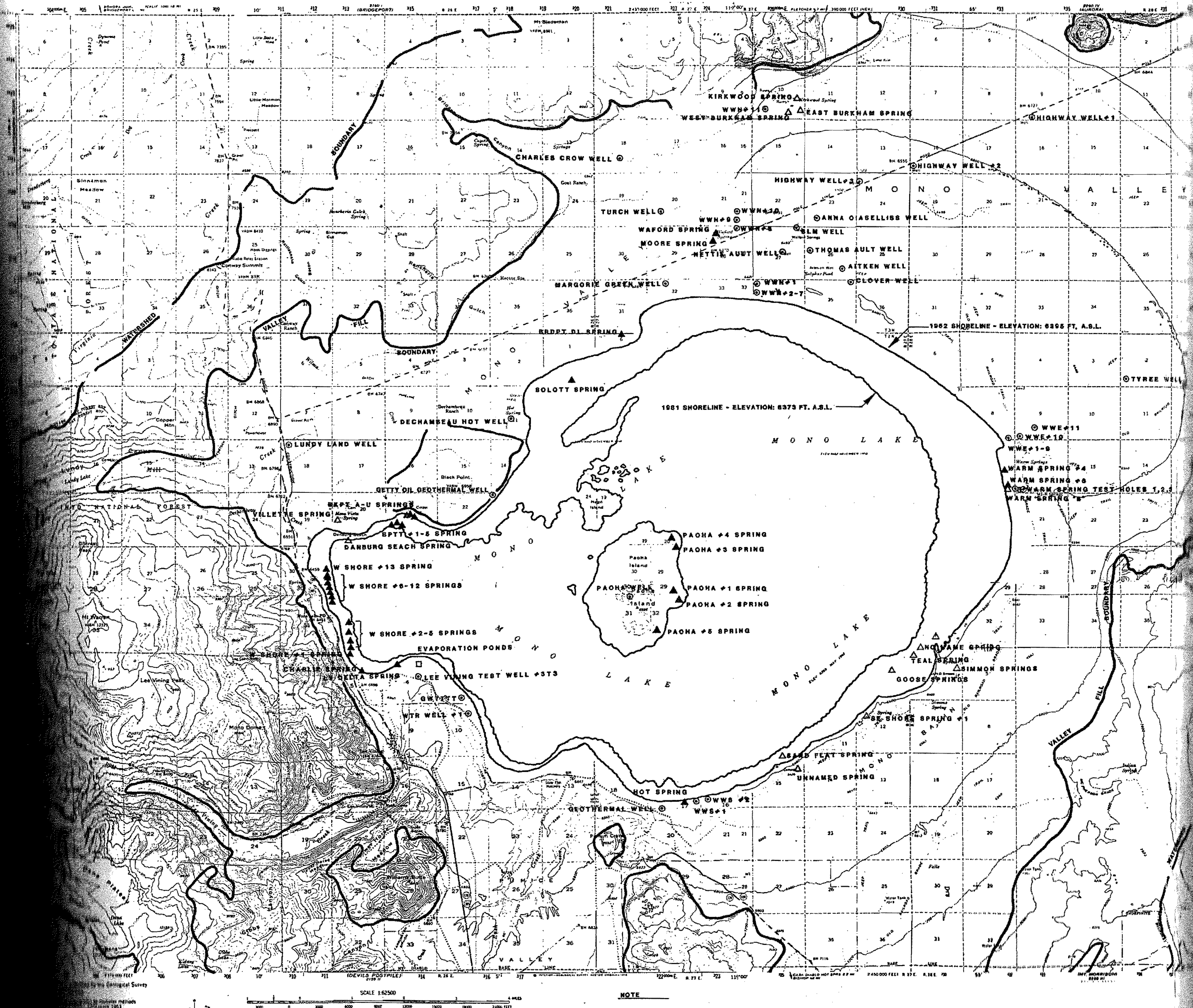
DISTRIBUTION OF WATER TYPES

FIGURE 18

FIGURE 19


MONO LAKE SPRING SURVEY
INDEX TO SUBAREAS


KIRKWOOD SPRING
WWN#11
EAST BURKHAM SPRING
WEST BURKHAM SPRING
HIGHWAY WELL#1
CHARLES CROW WELL
HIGHWAY WELL #2
HIGHWAY WELL#3
MONO VALLEY
TURCH WELL
WWN#9
WWN#10
WWN#8
WAFORD SPRING
MOORE SPRING
ANNA DIASELLISS WELL
ELM WELL
NETTIE AULT WELL
THOMAS AULT WELL
AITKEN WELL
MARGORIE GREEN WELL
WWN#1
WWN#2-7
CLOVER WELL
1962 SHORELINE - ELEVATION: 6296 FT. A.S.L.
BRDPT PT. SPRING
BOUNDARY
SOLOTT SPRING
TYREE WELL
1961 SHORELINE - ELEVATION: 6373 FT. A.S.L.
DECHAMBEAU HOT WELL
MONO LAKE
WWE#11
WWE#10
WWE#1-9
WARM SPRING #4
WARM SPRING #3
WARM SPRING TEST HOLES 1,2,3
WARM SPRING "5"
GETTY OIL GEOTHERMAL WELL
A-U SPRINGS
BPTT#1-5 SPRING
NBURG BEACH SPRING
PAOHA #4 SPRING
PAOHA #3 SPRING
HORE #13 SPRING
SHORE #6-12 SPRINGS
PAOHA WELL
PAOHA #1 SPRING
PAOHA #2 SPRING
PAOHA #5 SPRING
Paoha Island
Negit Island
W SHORE #2-5 SPRINGS
EVAPORATION PONDS
NO NAME SPRING
TEAL SPRING
SIMMON SPRINGS
GOOSE SPRINGS
TA SPRING
LEE VINING TEST WELL #373
GWTITT
WTR WELL #1
SE SHORE SPRING #1
SAND FLAT SPRING
UNNAMED SPRING
HOT SPRING
WWS #2
WWS#1
GEOTHERMAL WELL
VALLEY FILL BOUNDARY
WELL
FILL
Black Point
Mt Biedeman
Dechambeau Ranch
Copper Canyon
Rancheria Gulch



NOTE

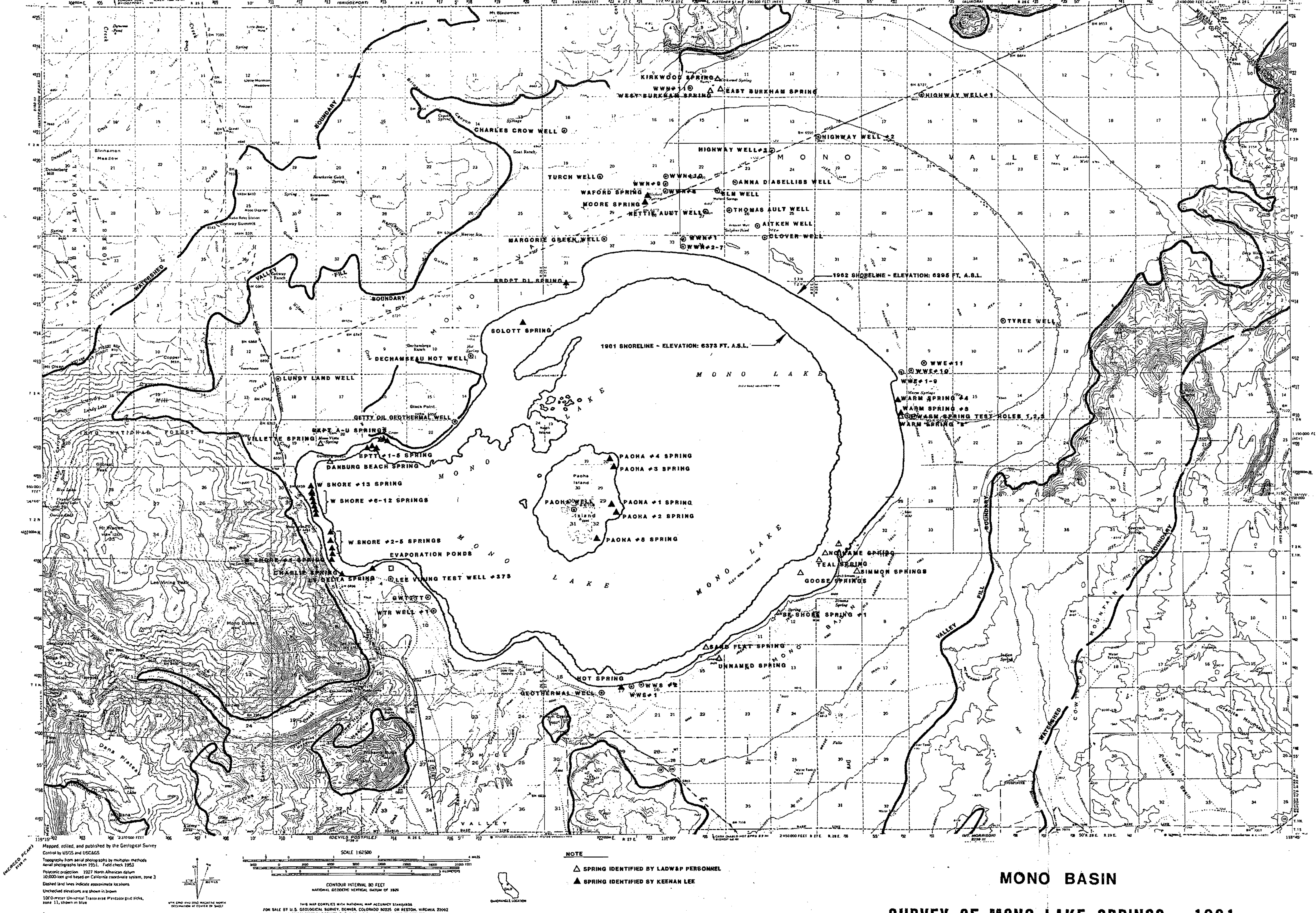
△ SPRING IDENTIFIED BY LADWAP PERSONNEL

▲ SPRING IDENTIFIED BY KEENAN LEE

MONO

SURVEY OF MONO LAK

FIGURE 19A

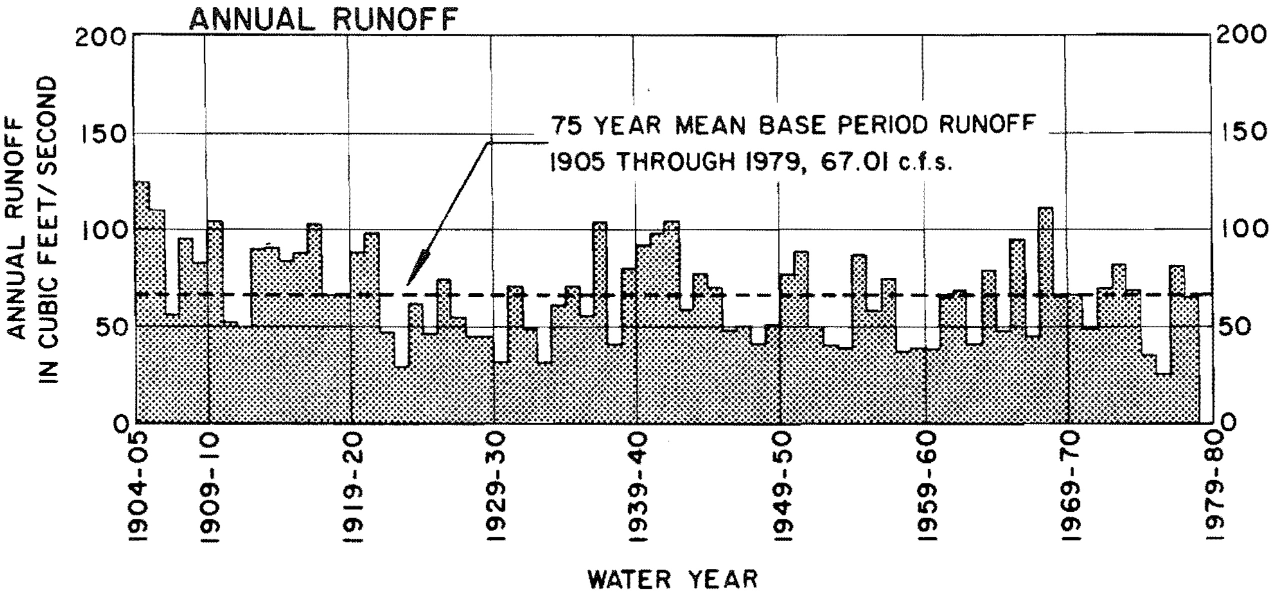


MONO BASIN

SURVEY OF MONO LAKE SPRINGS - 1981

FIGURE 20

LEE VINING CREEK NATURAL FLOW ANNUAL AND CUMULATIVE DEPARTURE FROM LONG-TERM MEAN



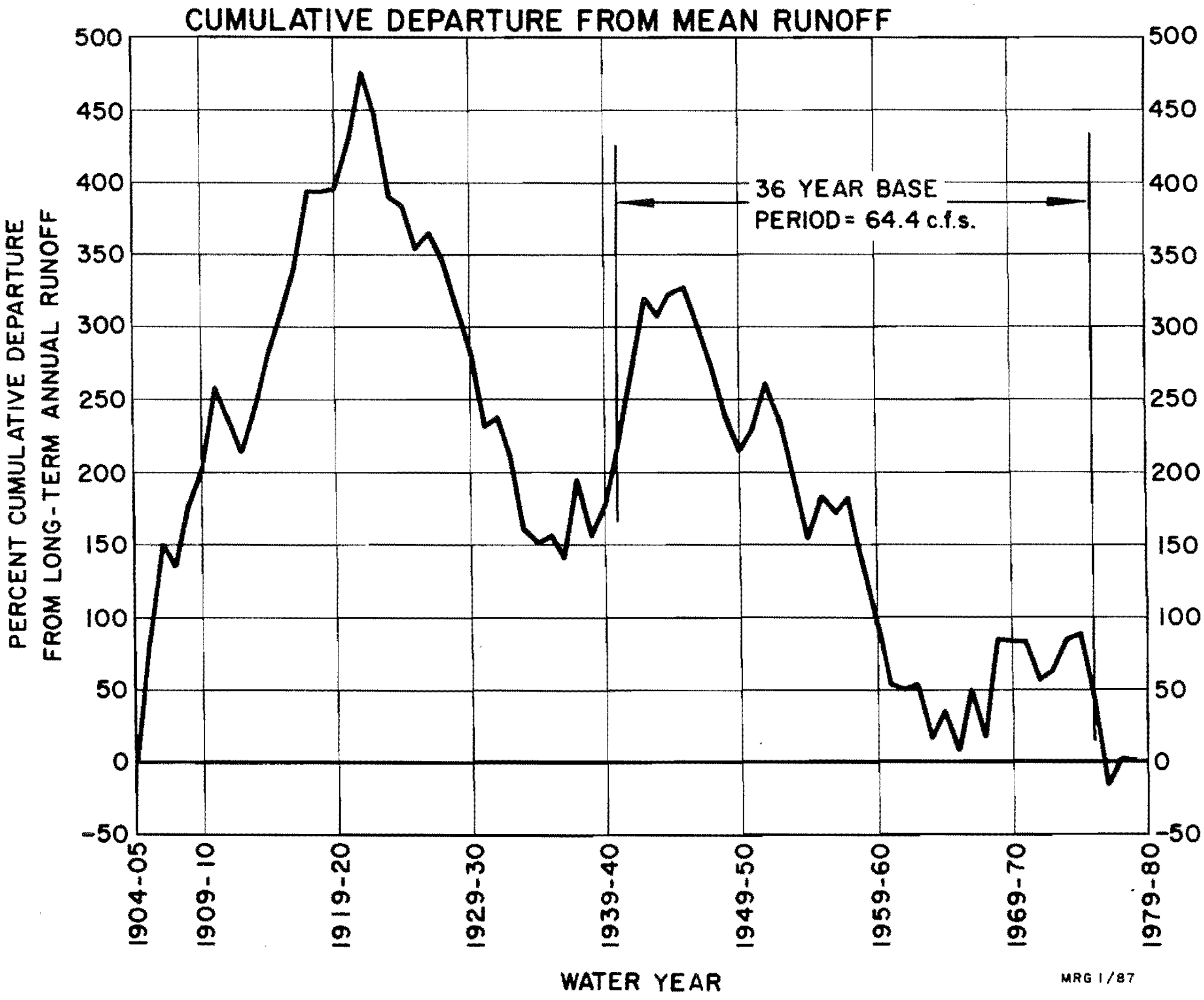


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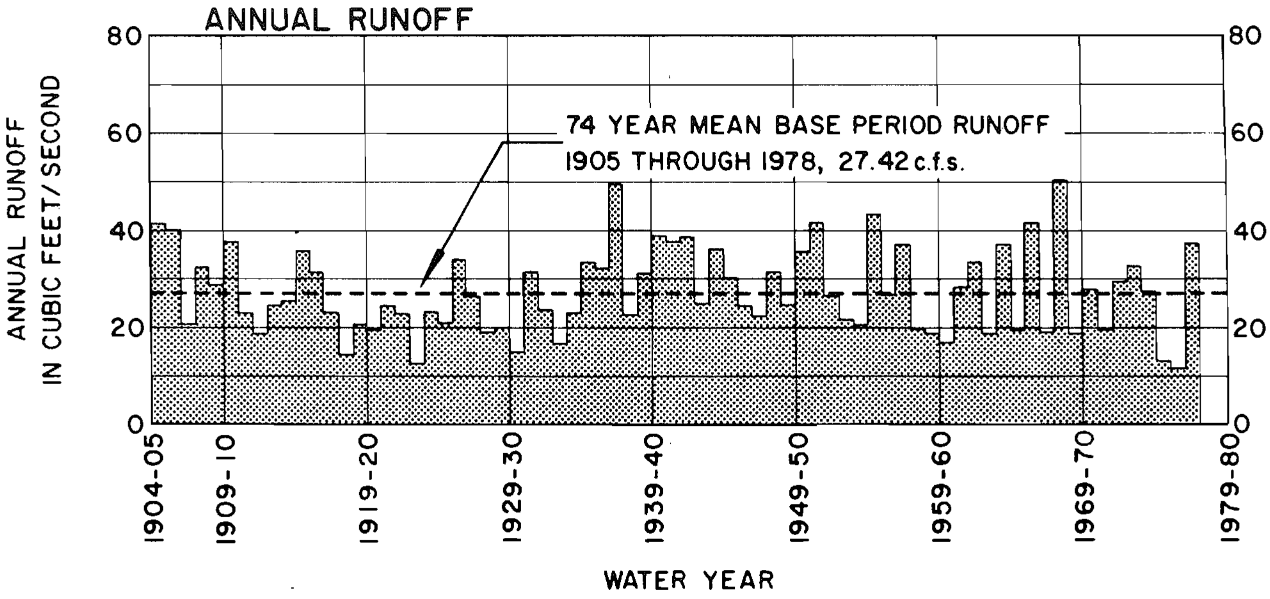
FIGURE 21

MILL CREEK NATURAL FLOW ANNUAL AND CUMULATIVE DEPARTURE FROM LONG-TERM MEAN



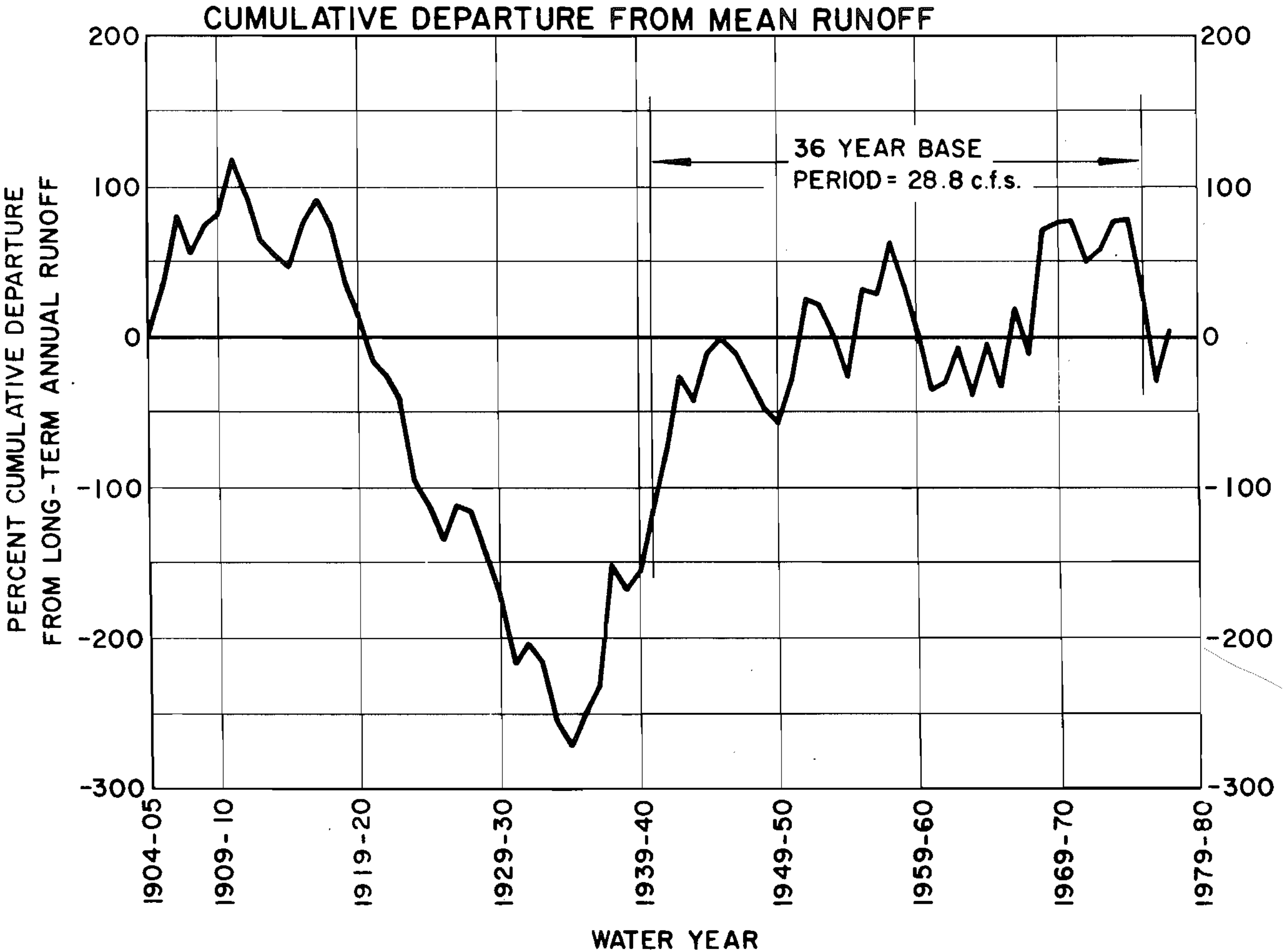


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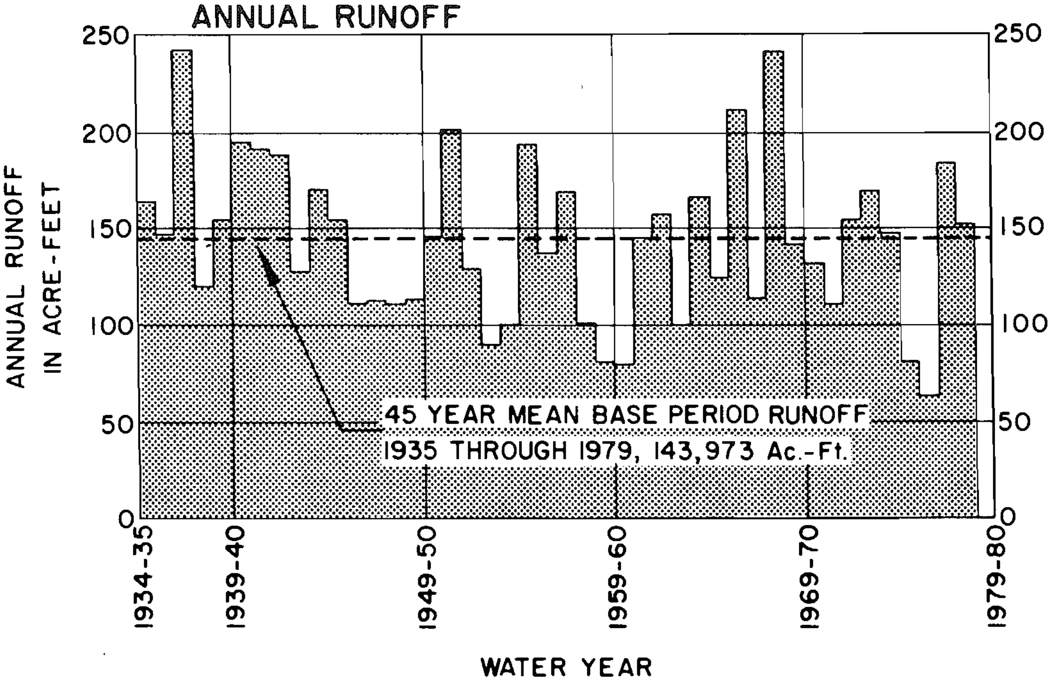
FIGURE 22

TOTAL MEASURED RUNOFF - MONO BASIN
ANNUAL AND CUMULATIVE DEPARTURE
FROM LONG-TERM MEAN



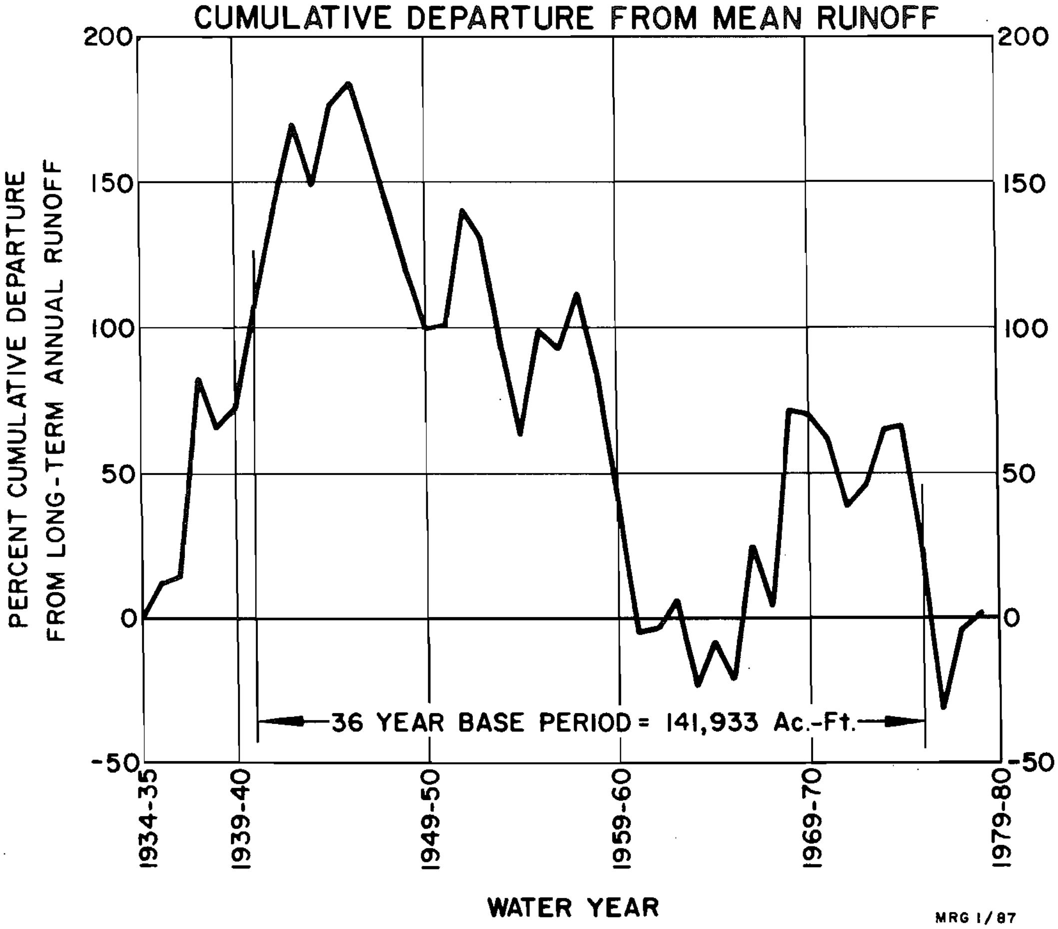


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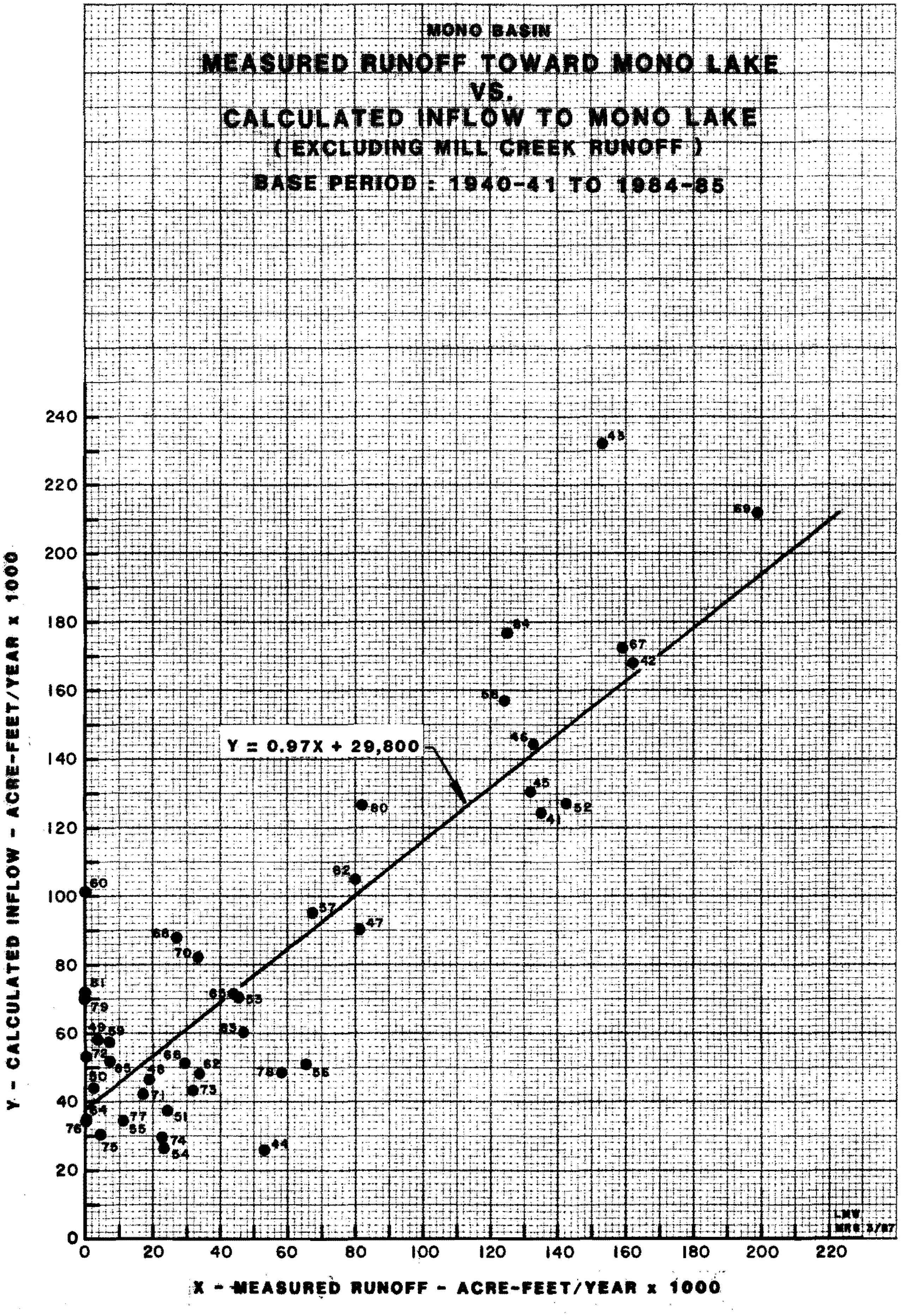
FIGURE 23



MONO BASIN

MEASURED RUNOFF TOWARD MONO LAKE

VS.

CALCULATED INFLOW TO MONO LAKE

(EXCLUDING MILL CREEK RUNOFF)

BASE PERIOD : 1940-41 TO 1984-85

FIGURE 24

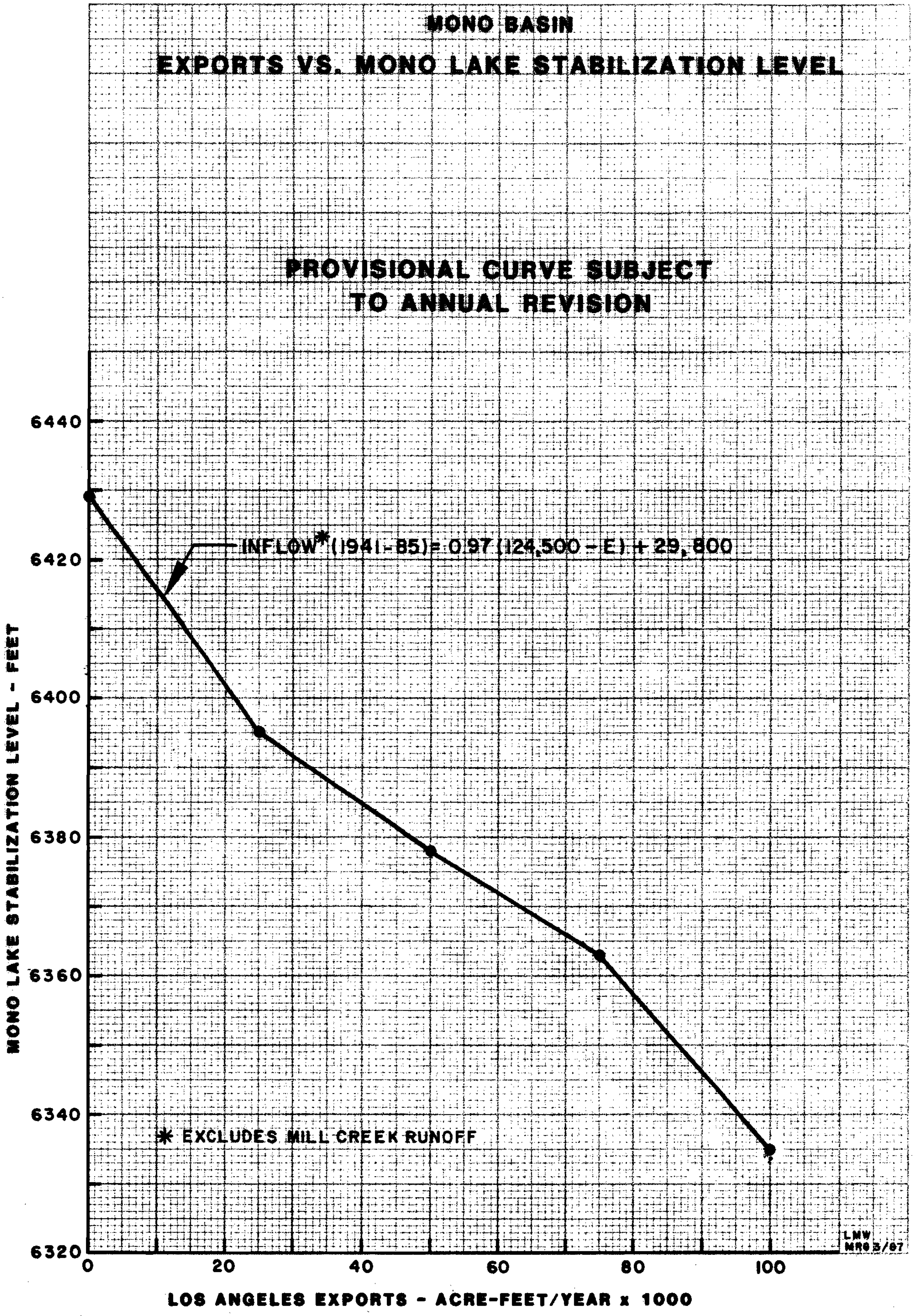
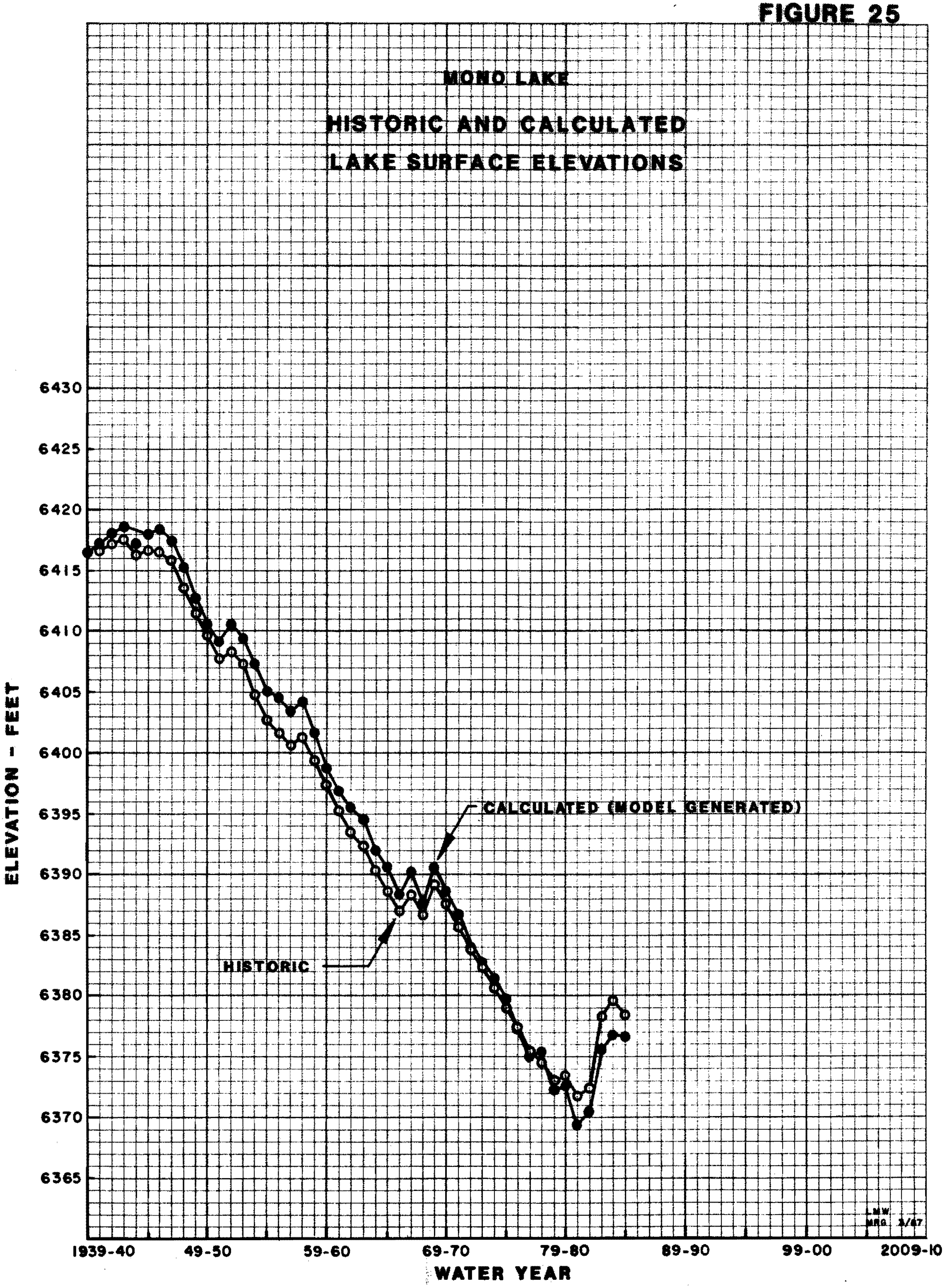
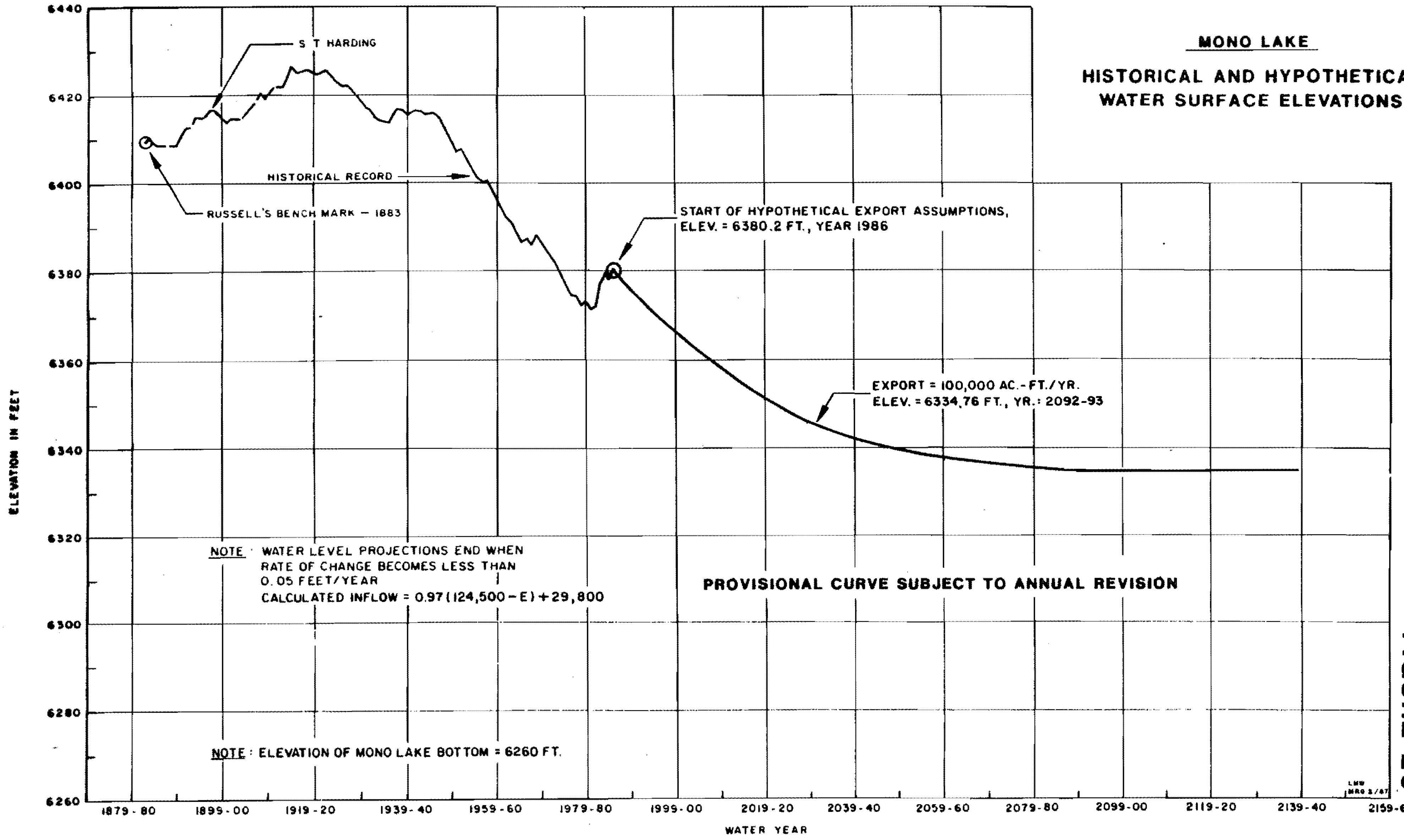

MONO BASIN
EXPORTS VS. MONO LAKE STABILIZATION LEVEL
PROVISIONAL CURVE SUBJECT TO ANNUAL REVISION
INFLOW*(1941-85)= 0.97(124,500 - E) + 29,800
* EXCLUDES MILL CREEK RUNOFF
MONO LAKE STABILIZATION LEVEL - FEET
6440
6420
6400
6380
6360
6340
6320
0
20
40
60
80
100
LOS ANGELES EXPORTS - ACRE-FEET/YEAR x 1000
LMW
MR6 3/87

FIGURE 25


MONO LAKE
HISTORIC AND CALCULATED
LAKE SURFACE ELEVATIONS
ELEVATION - FEET
6430
6425
6420
6415
6410
6405
6400
6395
6390
6385
6380
6375
6370
6365
CALCULATED (MODEL GENERATED)
HISTORIC
1939-40
49-50
59-60
69-70
79-80
89-90
99-00
2009-10
WATER YEAR
LMW
MRG 3/87



MONO LAKE

HISTORICAL AND HYPOTHETICAL WATER SURFACE ELEVATIONS

START OF HYPOTHETICAL EXPORT ASSUMPTIONS,
ELEV. = 6380.2 FT., YEAR 1986

EXPORT = 100,000 AC.-FT./YR.
ELEV. = 6334.76 FT., YR.: 2092-93

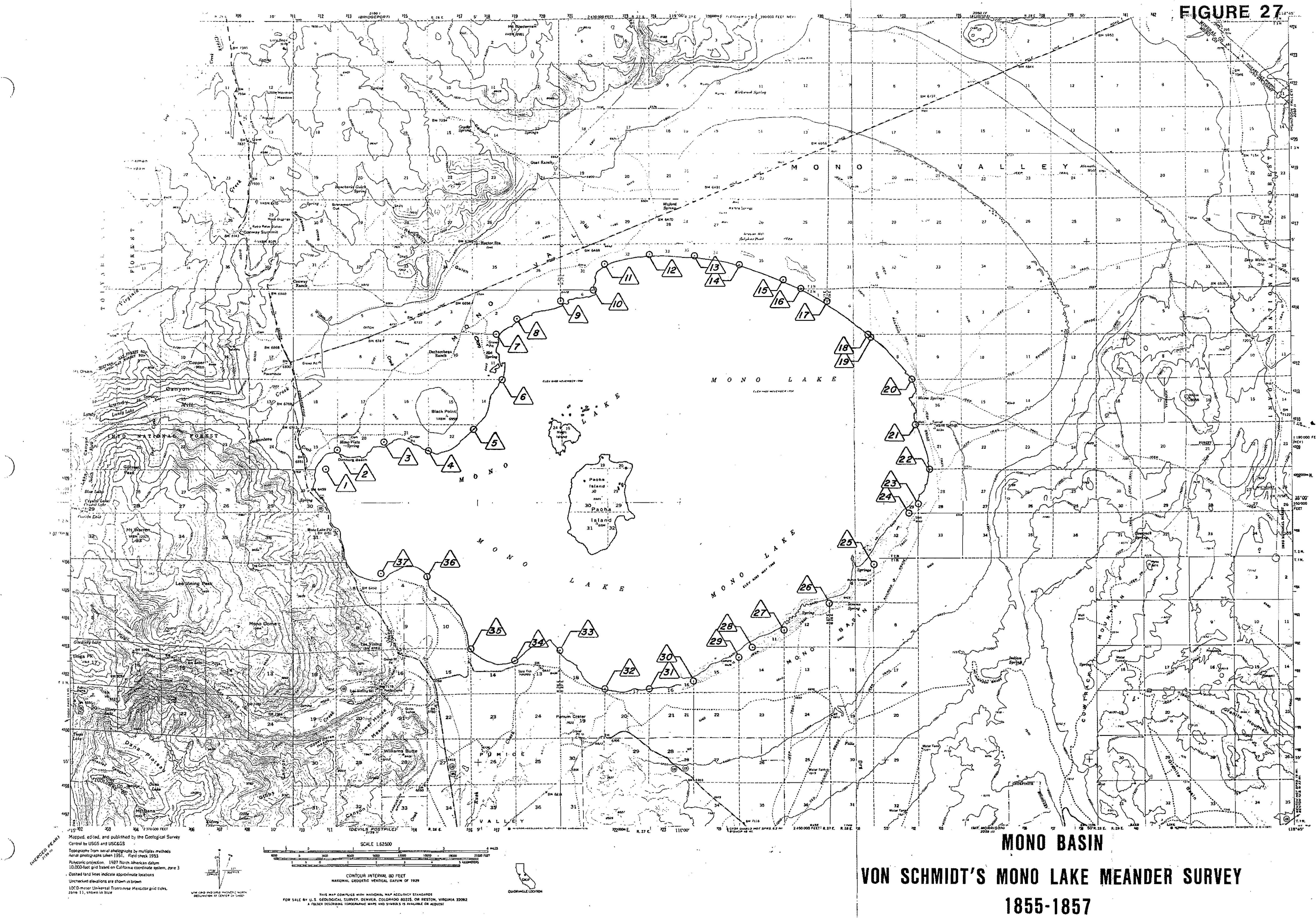
NOTE: WATER LEVEL PROJECTIONS END WHEN RATE OF CHANGE BECOMES LESS THAN 0.05 FEET/YEAR
CALCULATED INFLOW = 0.97(124,500 − E) + 29,800

PROVISIONAL CURVE SUBJECT TO ANNUAL REVISION

NOTE: ELEVATION OF MONO LAKE BOTTOM = 6260 FT.

FIGURE 26

FIGURE 27

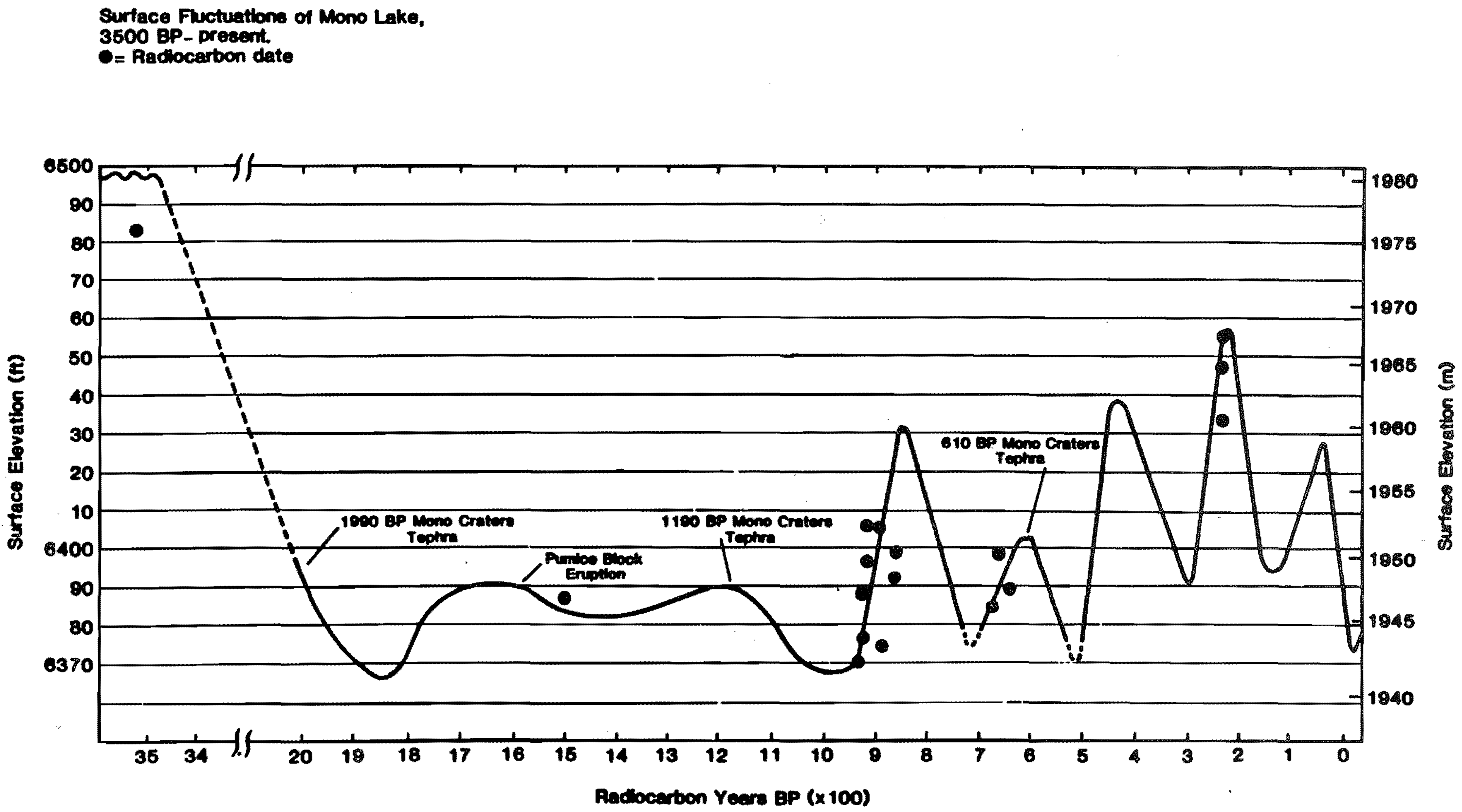


MONO BASIN

VON SCHMIDT'S MONO LAKE MEANDER SURVEY

1855-1857

(○ STATIONS PLOTTED FROM VON SCHMIDT'S SURVEY NOTES (BLM OFFICE-SACRAMENTO, CA.)



MONO LAKE

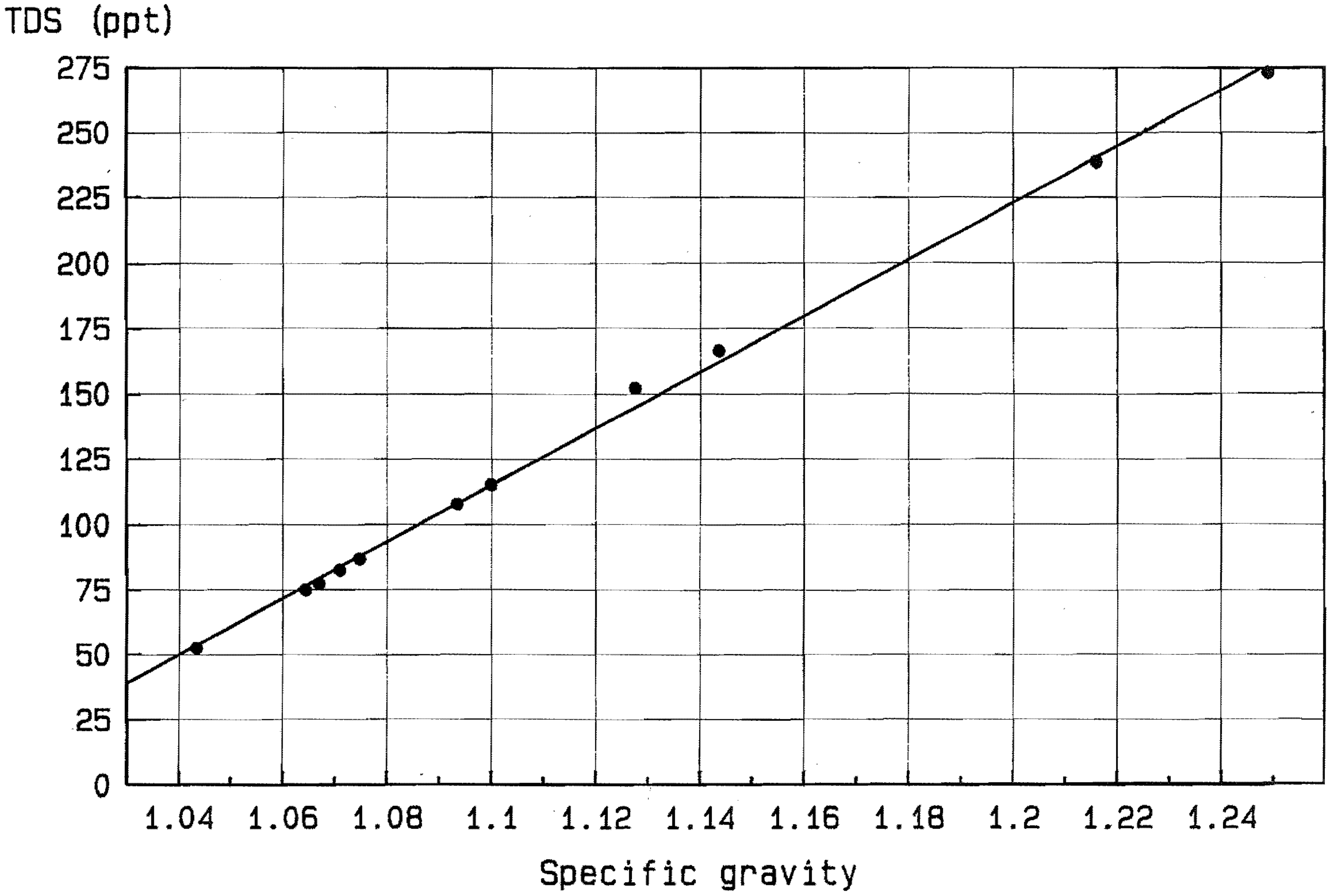
LATE HOLOCENE SURFACE LEVELS

Source: Stine, 1984

FIGURE 28

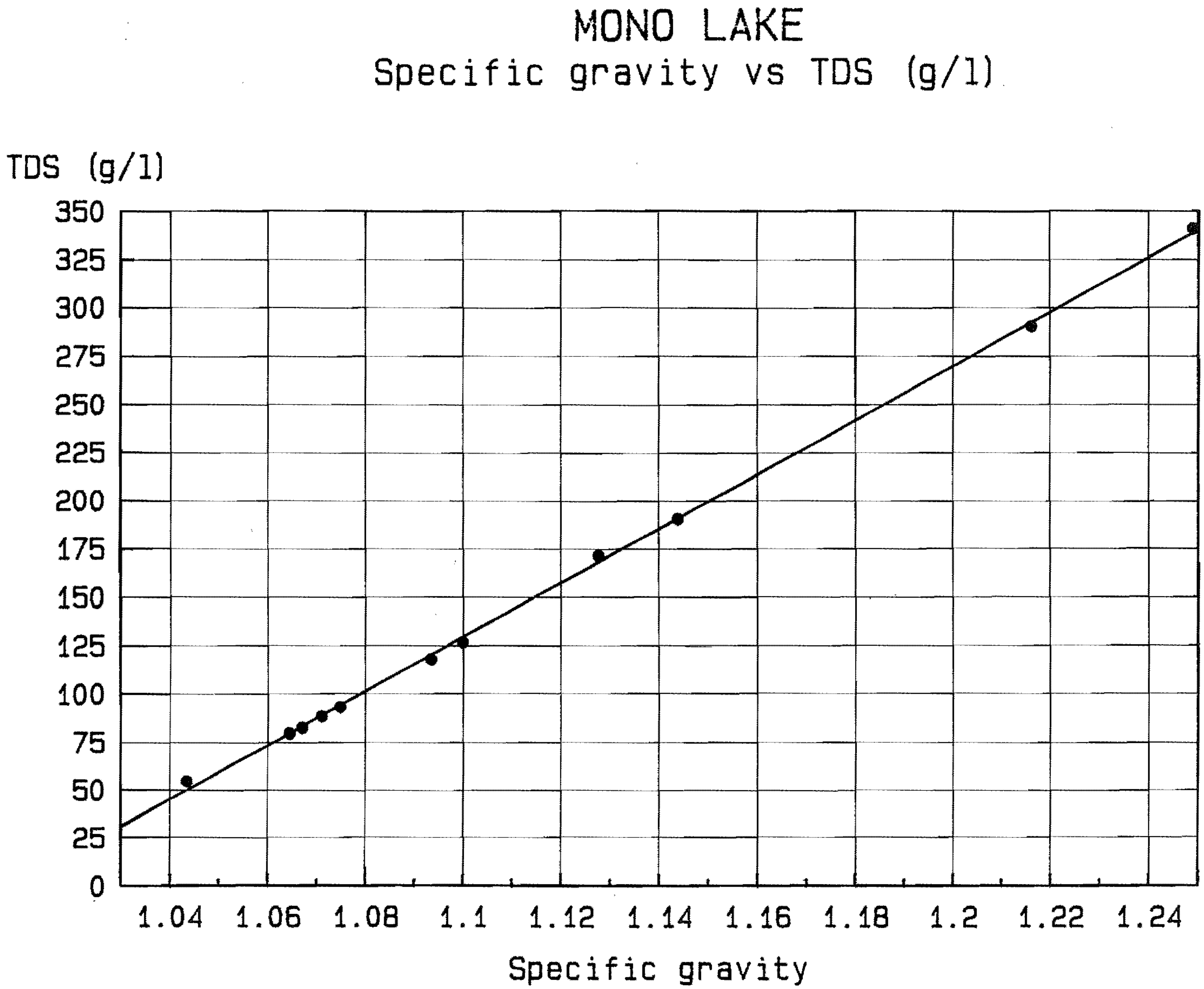
MONO LAKE

Specific gravity vs TDS (ppt)



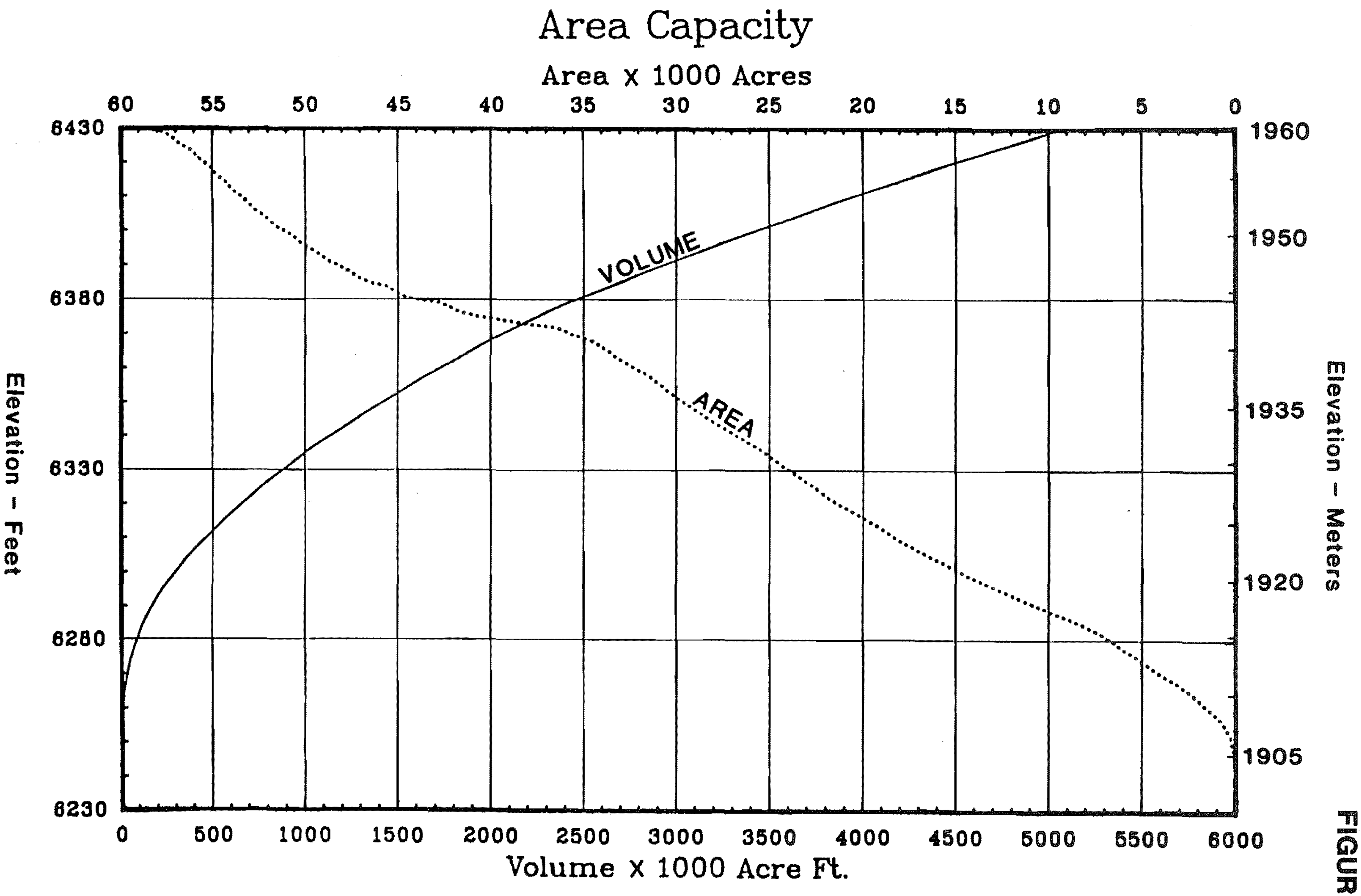
TDS (ppt) = total dissolved solids in parts per thousand

FIGURE 29



TDS (g/l) = Total Dissolved Solids in
grams per liter

FIGURE 30



AREA CAPACITY OF MONO LAKE

FROM: PELAGOS CORP., FEB. 1987

FIGURE 31

Plates

PLATE 1

MONO LAKE

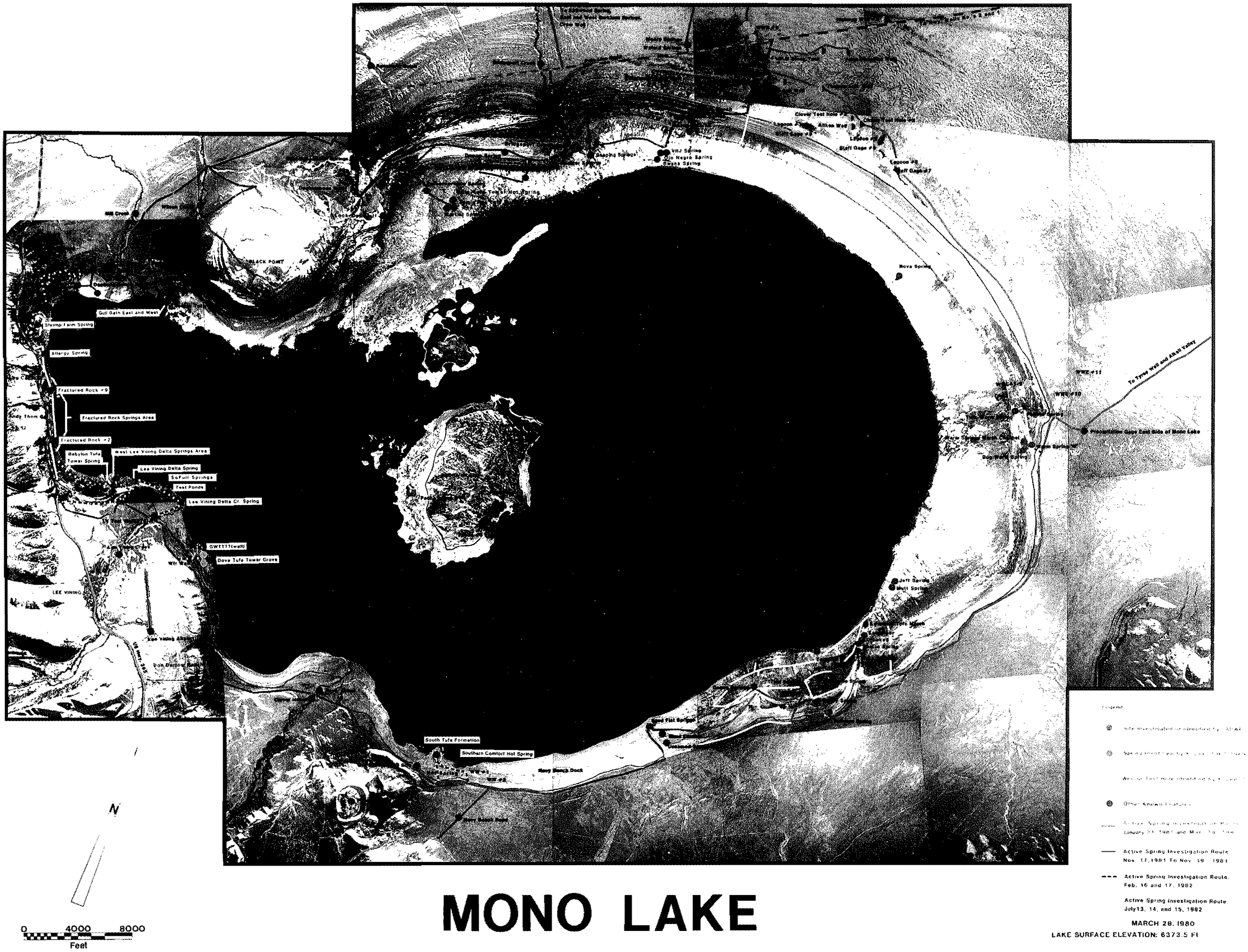
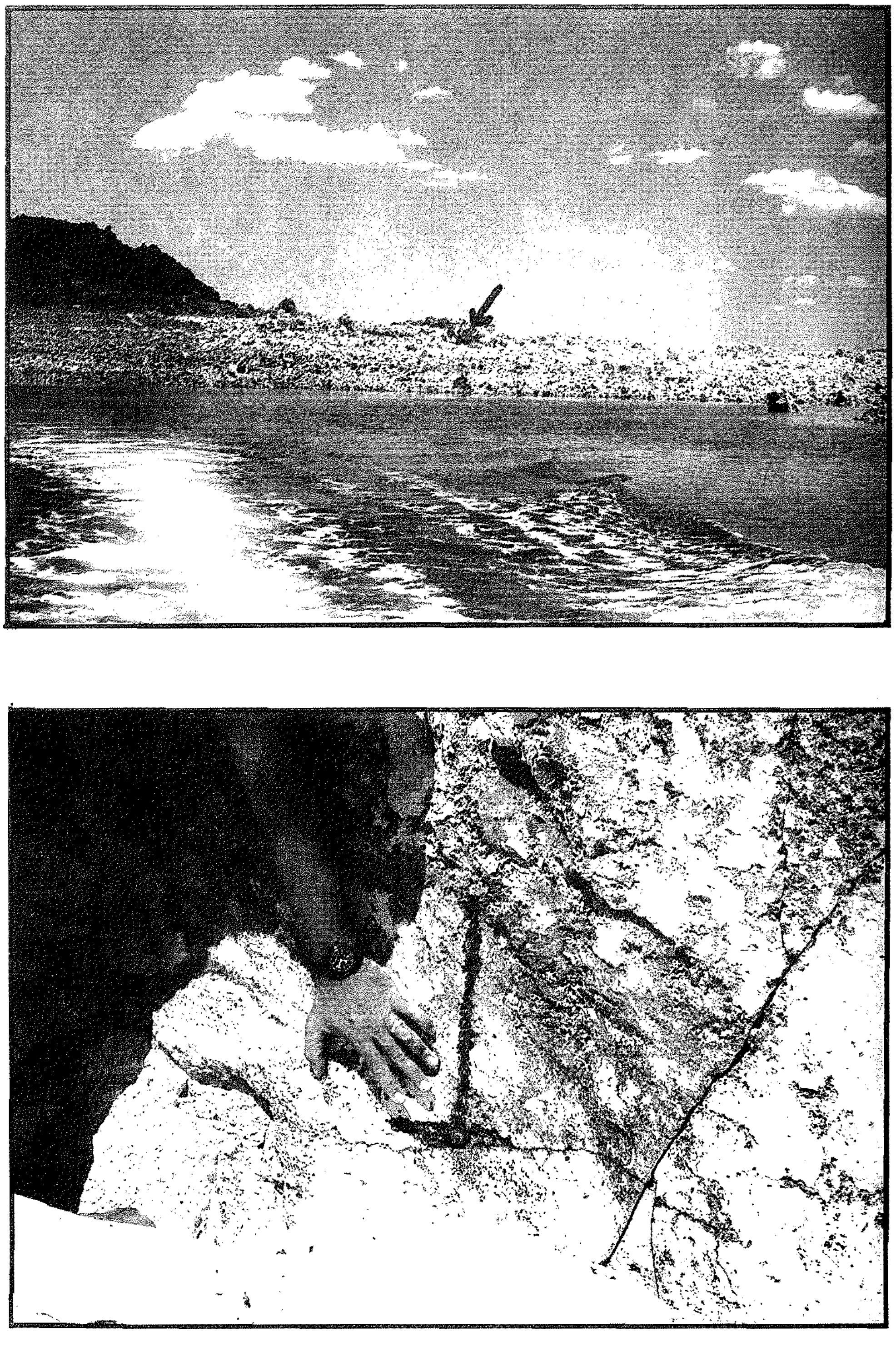


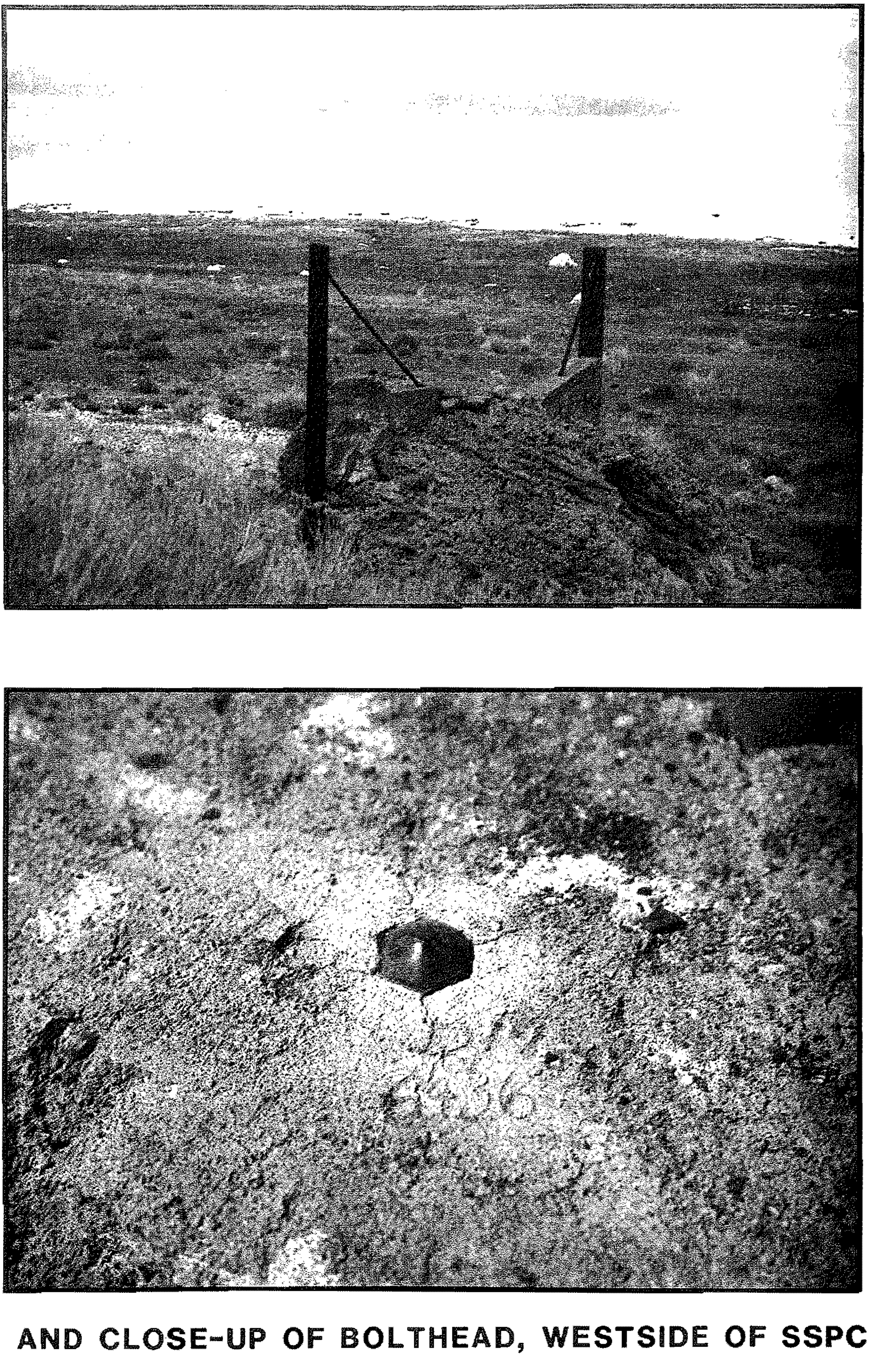
PLATE 4



LOCATION AND CLOSE-UP OF RUSSELL'S BENCH MARK ON S.W. CORNER OF NEGIT ISLAND.

AUG. 14, 1986

PLATE 5



LOCATION AND CLOSE-UP OF BOLTHEAD, WESTSIDE OF SSPC GAGING STATION, LOCATED ON WEST SHORE OF MONO LAKE, LOOKING EAST.

Appendix A

APPENDIX A

DEFINITIONS OF TERMS

Acre-foot

The volumetric equivalent of one acre covered to a depth of one foot, or about 326,000 gallons. An acre-foot of water would meet the needs of a family of five for one year.

Aerobic

Said of an organism that can live only in the presence of free oxygen.

Algae

Single-celled photosynthetic plants, usually aquatic.

Alluvial fan

A low, outspread, relatively flat to gently sloping mass of loose rock material shaped like an open fan, deposited by a stream at a place where it issues from a narrow mountain valley upon a plain or broad valley.

Alluvium

A general term for unconsolidated clay, silt, sand, and gravel deposited by a stream during relatively recent geologic time.

Aquiclude

A body of relatively impermeable rock that is capable of absorbing water slowly but functions as an upper or lower boundary of an aquifer and does not transmit water rapidly enough to supply a well or spring.

Aquifer

A body of rock that contains sufficient saturated permeable material to conduct ground water and to yield significant quantities of ground water to wells and springs.

Artesian

An adjective referring to ground water confined under hydrostatic pressure.

Basalt

A fine-grained black lava. See Figure 6.

Basement

Old igneous and metamorphic rocks upon which younger sedimentary rocks have been deposited.

Batholith

A very large mass of coarsely crystalline igneous rock formed by the intrusion of magma at great depth and later exposed by erosion.

Bathymetry

The measurement of ocean or lake depths and the charting of the topography of the ocean or lake floor.

Bedding

The arrangement of a sedimentary rock in beds or layers of varying thickness or character.

Bedrock

A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

Bench

A long, narrow, relatively level or gently inclined strip of land bounded by steeper slopes above and below.

Bench mark

A well-defined permanently fixed point, used as a reference from which measurements (such as elevations) may be made.

Bentonite

A type of clay used to thicken drilling muds.

Biogenic ooze

A fine-grained deposit in a deep portion of a large lake or the ocean which is characterized by an abundance of organic matter.

Block-and-ash flow deposit

An unsorted deposit of volcanic ash and blocks which was ejected explosively, along with high temperature gases, from fissures or a crater.

Breccia

A coarse-grained rock consisting of broken and angular rock fragments cemented in a finer-grained matrix.

Cable-tool

A method of drilling based on a percussion principle in which the rock at the bottom of the hole is pulverized by a solid-steel cylindrical bit suspended on a cable.

Caldera

A large basin-shaped volcanic depression, circular to oval in shape, with a diameter much greater than its depth.

Clastic

A rock or sediment composed of broken fragments of pre-existing rocks.

Confined ground water

Ground water under pressure significantly greater than that of the atmosphere and whose upper surface is the bottom of a bed of much lower permeability than the layer in which the water occurs.

Consumptive use

The transformation of water from the liquid to the gaseous form by soil evaporation or evapotranspiration by plants.

Coulee

A flow of viscous lava that has a blocky, steep-fronted form.

Cubic foot per second (cfs)

A flow of one cubic foot per second is equal to a flow of 449 gallons per minute, or 724 acre-feet in a year.

Dacite

A fine-grained extrusive volcanic rock. See Figure 6.

Delta

A triangular deposit of alluvium near the mouth of a river or creek.

Dendritic tufa

Gray tufa that has crystallized in a branching pattern.

Deuterium

An isotope of hydrogen.

Diatom

A microscopic, single-celled plant growing in fresh or saline bodies of water. The remains form a deposit of silica called diatomaceous earth.

Dome (volcanic)

A steep-sided, rounded extrusion of highly viscous lava squeezed out from a volcano.

Dune flow deposit

A deposit of coarse volcanic material south and west of Panum Crater (Sieh and Bursik, 1986). Deposited from a hot volcanic cloud, which left large sand-dune like ridges.

Ejecta

Material thrown out of a volcano.

Escarpment

A long, more or less continuous cliff or relatively steep slope facing in one general direction.

Evapotranspiration

Loss of water from a land area through transpiration of plants and evaporation from soil.

Fault

A surface of rock fracture along which there has been displacement.

Fault zone

A zone in the earth's crust consisting of many nearly parallel faults and fractures. May be several miles wide.

Fluvial

Of or pertaining to a river or rivers.

Formation

A mappable geologic unit characterized by distinct and recognizable features.

Gneiss

A metamorphic rock characterized by alternating bands of granular minerals and platy minerals.

Granite

A light-colored, coarse-grained plutonic igneous rock. See Figure 6.

Granodiorite

A plutonic igneous rock resembling granite. See Figure 6.

Ground water

That part of the water below the surface of the ground which is below the water table.

Holocene

An epoch of the Quaternary period, from the end of the Pleistocene to the present time. See Table 1.

Hydrostatic pressure

The pressure exerted by a column of water.

Hysteresis

The time lag exhibited by a system in reacting to the forces which act upon it.

Hypopycnal (inflow)

Flowing water that is less dense than the body of water it enters.

Igneous Rock

A rock that has solidified from a molten condition.

Ignimbrite

A rock formed by the deposition and consolidation of volcanic ash flows. Sometimes called a welded tuff.

Interglacial

Pertaining to or formed during the time interval between two glacial advances.

Intermittent stream

A stream, or reach of a stream that flows only at certain times of the year.

Lacustrine (lacustral)

Pertaining to, produced by, or formed in a lake.

Lateral moraine

A ridge of loose materials formed on the side of a valley glacier.

Lithoid tufa

Gray, compact tufa occurring in the core of tufa towers.

Magma

Molten rock deep beneath the surface of the earth.

Meander

To survey a line which runs approximately along the margin or bank of a permanent natural body of water.

Metasediments

Sedimentary rocks which have been metamorphosed.

Metavolcanics

Volcanic rocks which have been metamorphosed.

Metamorphic rock

A rock which has been changed from its original form by the agencies of heat and pressure.

Meteoric (water)

Pertaining to water of recent atmospheric origin.

Morainal displacement

The offsetting of a morainal ridge by faulting.

Moraine

A mound, ridge or other distinct accumulation of unsorted, unstratified glacial drift, predominantly till.

Normal year

A year in which precipitation and stream flow are close to that of the long-term average.

Obsidian

A black or dark-colored volcanic glass. See Figure 6.

Orographic influence

The effect of a high mountain barrier in causing precipitation from moisture-laden air which is forced to rise over it.

Ostracodes

Minute animals with bean-shaped shells composed of calcium carbonate.

Phreatophyte

A plant that obtains its water supply from the zone of saturation or the capillary fringe.

Planimeter

A mechanical instrument used for measuring irregular areas on a chart or map.

Pleistocene

The epoch of the Quaternary period before the Holocene. The Ice Age. See Table 1.

Precipitation

The discharge of water (as rain, snow, hail, or sleet) from the atmosphere upon the Earth's surface.

Pumice

A light-colored, vesicular (frothy) rock commonly having the composition of a rhyolite. See Figure 6.

Pyroclastic rock

A rock composed of materials fragmented by a volcanic explosion.

Pyroclastic flow

A cloud of pyroclastics and hot gases resulting from a violent volcanic eruption.

Pyroclastic surge beds

Fine-grained layered volcanic deposits formed where magma and external ground water or open bodies of water have reacted violently.

Quaternary

The second period of the Cenozoic era, following the Tertiary. See Table 1.

Radiocarbon dating

A method of determining an age in years by measuring the concentration of carbon-14 remaining in organic matter. Used to determine geologic ages up to 40,000 years.

Recharge

The processes involved in the addition of water to the zone of saturation -- from precipitation, percolation from streams, unlined channels, and applied irrigation water.

Relief

The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region.

Rhyolite

A light-colored, fine-grained extrusive igneous rock. See Figure 6.

Roof pendant

A downward projection of the country rock into a magma chamber. When exposed by erosion, they are metamorphic rocks.

Scarp

A line of cliffs produced by faulting or by erosion.

Schist

A metamorphic rock which can be split into thin flakes because of the parallelism of its flat mineral grains.

Sedimentary rock

A rock resulting from the consolidation of loose (clastic) sediment into layers, chemical deposits such as salt and gypsum, and organic deposits such as coral reefs.

Shale

A fine-grained sedimentary rock formed by the consolidation of clay, silt, or mud.

Stratified

Formed, arranged, or laid down in layers or strata. Typical of sedimentary rocks.

Subaerial

Occurring beneath the atmosphere or in the open air.

Sublacustrine

Existing or formed beneath the waters, or on the bottom, of a lake.

Talus

Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep rocky slope.

Tephra

A general term for all pyroclastics of a volcano.

Thinolitic tufa

A tufa consisting of delicate, interlaced, skeletal crystals.

Till

Unsorted and unstratified glacial deposits, generally unconsolidated. Deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. A mixture of clay, sand, gravel and boulders. Commonly called boulder clay.

Tufa

A chemical sedimentary rock composed of calcium carbonate, formed by evaporation as a thin, surficial, soft, spongy, cellular, or porous incrustation around the mouth of a hot or cold spring. Adjective is tufaceous.

Tufa tower

A mound-like deposit of tufa formed around the orifice of a spring exiting from the bottom of an alkaline lake. The structure forms beneath the lake and grows toward the surface of the lake as the orifice is extended upward by deposition of calcium carbonate. Synonyms are tufa pinnacle and tufa crag.

Tuff

A compacted pyroclastic deposit of volcanic ash and dust. Adjective is tuffaceous.

Unconfined ground water

Ground water that has a free water table; i.e., water not confined under pressure beneath a layer of low permeability.

Vitric

Said of pyroclastic material that is characteristically glassy.

Water table

The surface between the zone of aeration and the zone of saturation. The base of the capillary fringe.

Whipstock

A procedure for drilling a well away from the vertical. Also called directional drilling.

Xerophyte

A plant adapted to dry conditions.

Zone of saturation

A subsurface zone in which all of the pore spaces are filled with water under pressure greater than that of the atmosphere. Its upper surface is the water table.

Appendix B

APPENDIX B

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Appendix C

APPENDIX C

MONO BASIN SPRINGS

Alphabetical Listing

SPRING NAME	SUB-AREA	LOCATION	FIRST DATE of MEAS.	LAST DATE of MEAS.	COMMENTS
ABALOS	SE	NWQSEC6R28ET1N	07/14/82	08/19/86	DWP
ALLERGY	W	NEQSEC30R26ET2N	05/27/81	07/09/81	DWP,DISPERSED
BABYLON TT	SW	NWQSEC4R26ET1N	08/25/82	08/20/86	DWP
BACON CYN	N	NEQSEC30R26ET3N	09/02/80	/ /	BLM DATA
BDGPRTCY(306)	N	NEQSEC15R26ET3N	02/22/68	/ /	LEE DATA
BKPT A(314)	NW	NWQSEC21R26ET2N	02/23/68	/ /	LEE DATA
BKPT B-U	NW	NWQSEC21R26ET2N	05/09/68	/ /	LEE DATA
BLANCHE MILL	N	NWQSEC28R26ET3N	08/05/80	/ /	BLM DATA
BLKPT 1-7	NW	NWQSEC21R26ET2N	11/14/67	/ /	LEE DATA
BPTT 1(405)	NW	SWQSEC21R26ET2N	05/07/68	/ /	LEE DATA
BPTT 2	NW	SWQSEC21R26ET2N	05/07/68	/ /	LEE DATA
BPTT 3(406)	NW	SWQSEC21R26ET2N	05/07/68	/ /	LEE DATA
BPTT 4(407)	NW	SWQSEC21R26ET2N	05/07/68	/ /	LEE DATA
BPTT 5(402)	NW	SWQSEC21R26ET2N	05/05/68	/ /	LEE DATA
BRDGPT CRK	N	SEQSEC31R27ET3N	11/18/81	/ /	DWP,DISPERSED
BRDGPT CYN CRK	N	SWQSEC14R26ET3N	09/16/80	/ /	BLM DATA
BRDGPTDL(310)	N	SEQSEC31R27ET3N	02/22/68	/ /	LEE DATA
BUG WARM	E	SEQSEC17R28ET2N	07/14/82	08/19/86	DWP
BWANA	N	SWQSEC33R27ET3N	11/18/81	08/01/84	DWP,SUBMERGED
CHARLIE(206)	SW	NEQSEC5R26ET1N	11/11/67	08/20/86	LEE,NOW DWP
CHUCK	N	SEQSEC6R27ET2N	11/19/81	08/01/84	DWP,SUBMERGED
CO. PARK 1	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 2	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 3	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 4	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 5	NW	SWQSEC20R26ET1N	08/24/82	08/18/86	DWP
CO. PARK 6	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 7	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CO. PARK 8	NW	SWQSEC20R26ET2N	08/24/82	08/18/86	DWP
CONWAY SUMMIT 1	N	SEQSEC26R25ET3N	08/03/30	/ /	BLM DATA
CONWAY SUMMIT 2	N	NEQSEC35R25ET3N	08/30/80	/ /	BLM DATA
CONWAY SUMMIT 3	N	NEQSEC35R25ET3N	08/30/80	/ /	BLM DATA
CONWAY SUMMIT 4	N	SEQSEC35R25ET3N	08/30/80	/ /	BLM DATA
COW	N	SWQSEC32R27ET3N	11/19/81	10/03/85	DWP,DISPERSED
COYOTE MARSH	N	NWQSEC12R26ET2N	11/19/81	08/21/84	DWP,DISPERSED
COYOTE(305)	N	SWQSEC14R26ET3N	02/22/68	/ /	LEE DATA
CROOKED CHNL	SE	NWQSEC6R28ET1N	07/14/82	09/21/86	DWP
CTTNWOOD CYN 1	N	SWQSEC19R27ET4N	09/03/80	/ /	BLM DATA
CTTNWOOD CYN 2	N	SWQSEC19R27ET4N	09/03/80	/ /	BLM DATA
CTTNWOOD CYN 3	N	W1/2SEC19R27ET4N	09/03/80	/ /	BLM DATA
CTTNWOOD CYN 4	N	W1/2SEC19R27ET4N	09/03/80	/ /	BLM DATA
DANBURG BEACH	NW	SWQSEC20R26ET2N	07/17/80	03/20/83	DWP,SUBMERGED
DECHMBO CO PK	NW	SEQSEC19R26ET2N	12/10/82	08/18/86	DWP,CREEK

APPENDIX C (cont.)

MONO BASIN SPRINGS

Alphabetical listing

SPRING NAME	SUB-AREA	LOCATION	FIRST DATE of MEAS.	LAST DATE of MEAS.	COMMENTS
DECHMBO CRK SPG	NW	NEQSEC24R25ET2N	08/04/80	/ /	BLM DATA
DEWAP	N	NEQSEC6R27ET2N	11/19/81	/ /	DWP,DISPERSED
DRINKIN FOUNT	NW	SWQSEC21R26ET2N	09/21/83	/ /	DWP,DRY
DRY CK(511)	SE	NWQSEC23R28ET1S	08/05/68	/ /	LEE DATA
EBURKHAM(308)	N	SEQSEC10R27ET3N	02/22/68	/ /	LEE DATA
FALLEN TT	SW	NWQSEC4R26ET2N	09/21/83	/ /	DWP, DRY
FINCH	SE	NWQSEC26R28ET1N	09/02/80	/ /	BLM DATA
FRACT ROCK 1	W	SWQSEC32R26ET2N	05/27/81	08/21/86	DWP
FRACT ROCK 2	W	SWQSEC32R26ET2N	05/27/81	08/21/86	DWP
FRACT ROCK 8	W	NWQSEC32R26ET2N	05/27/81	/ /	DWP,DISPERSED
FRACT ROCK 9	W	NWQSEC32R26ET2N	05/27/81	09/20/83	DWP,DISPERSED
GOAT RANCH 1	N	SWQSEC18R27ET3N	08/16/80	/ /	BLM DATA
GOAT RANCH 2	N	SEQSEC18R27ET3N	08/16/80	/ /	BLM DATA
GOOSE,EAST	SE	SWQSEC1R27ET1N	01/12/81	08/19/86	DWP
GOOSE,NORTH	SE	SWQSEC1R27ET1N	01/12/81	08/19/86	DWP
GOOSE,WEST	SE	SWQSEC1R27ET1N	01/12/81	08/19/86	DWP
GULBTH,EAST	NW	SWQSEC21R26ET2N	08/24/82	08/19/86	DWP
GULBTH,WEST(EF)	NW	SWQSEC21R26ET2N	08/24/82	08/19/86	DWP
GULBTH,WEST(MF)	NW	SWQSEC21R26ET2N	08/24/82	08/19/86	DWP
GULBTH,WEST(WF)	NW	SWQSEC21R26ET2N	08/24/82	08/19/86	DWP
HAWS STLAGMIT	NW	NWQSEC21R26ET2N	09/20/83	08/19/86	DWP
HOELZER	N	NWQSEC5R27ET2N	11/18/81	/ /	DWP,DISPERSED
HOT	S	SEQSEC17R27ET1N	02/17/82	08/20/86	DWP
HOT SPG1(203)	S	SWQSEC17R27ET1N	11/11/67	/ /	LEE,SEE DWP HO
HOT SPG3	S	SWQSEC17R27ET1N	11/11/67	/ /	LEE DATA
HOT SPG5	S	SWQSEC17R27ET1N	11/11/67	/ /	LEE DATA
HOT SPRG BP	NW		09/20/57	/ /	FETH DATA
HOTSPG 2(201)	S	SWQSEC17R27ET1N	11/11/67	/ /	LEE DATA
INDIAN	SE	SEQSEC1R28ET1N	02/21/68	/ /	LEE DATA
INDIAN	SE	NEQSEC14R28ET1N	09/02/80	/ /	BLM DATA
JAMIE HOT TT	N	NEQSEC12R26ET2N	11/19/81	08/01/83	DWP,SUBMERGED
JEFF	SE	SWQSEC31R28ET2N	07/14/82	/ /	DWP,NOT FOUND
KIRKWOOD	N	SEQSEC10R27ET3N	04/25/69	/ /	LEE DATA
LAUREL'S	NW	NWQSEC21R26ET2N	08/19/86	/ /	DWP
LV CRK DELTA	SW	NWQSEC3R26ET1N	02/17/82	08/19/86	DWP
LV DELTA	SW	NWQSEC4R26ET1N	05/27/81	02/13/84	DWP,SUBMERGED
LV DELTA 1	SW	NWQSEC4R26ET1N	11/12/67	05/27/81	LEE,NOW DWP
LV DELTA 2	SW	NWQSEC4R26ET1N	11/12/67	05/27/81	LEE,NOW DWP
LV DELTA 3	SW	NWQSEC4R26ET1N	02/22/68	05/19/83	LEE,NOW DWP
LV DELTA 4	SW	NWQSEC4R26ET1N	05/27/81	/ /	DWP,NOT FOUND
LV DELTA 5	SW	NWQSEC4R26ET1N	05/27/81	/ /	DWP,NOT FOUND
MARGARITA MRSH	N	NEQSEC33R27ET3N	11/18/81	/ /	DWP,DISPERSED
MARTINI	N	NEQSEC12R26ET2N	11/19/81	08/21/84	DWP,SUBMERGED
MEX CANYON 1	N	SWQSEC6R28ET4N	09/16/80	/ /	BLM DATA
MEX CANYON 2	N	NEQSEC6R27ET4N	09/16/80	/ /	BLM DATA
MEX CANYON 3	N	NWQSEC8R28ET4N	09/16/80	/ /	BLM DATA

MONO BASIN SPRINGS

Alphabetical Listing

SPRING NAME	SUB-AREA	LOCATION	FIRST DATE of MEAS.	LAST DATE of MEAS.	COMMENTS
MOLASSES CHNL	SE	NEQSEC1R27ET1N	07/13/82	08/25/82	DWP,SUBMERGED
MONO DIGGINS	N	NWQSEC30R26ET3N	08/04/80	/ /	BLM DATA
MONOVIS A(312)	NW	NWQSEC20R26ET2N	02/23/68	/ /	LEE DATA
MONOVIS B	NW	NWQSEC20R26ET2N	11/14/67	/ /	LEE DATA
MONOVIS C-U	NW	SEC19&20R26ET2N	05/10/68	/ /	LEE DATA
MONOVIS M(411)	NW	SEQSEC19R26ET2N	05/10/68	/ /	LEE DATA
MONOVIS X	NW	SEQSEC19R26ET2N	06/24/68	/ /	LEE DATA
MOORES	N	NWQSEC28R27ET3N	11/13/67	08/15/68	LEE DATA
MRG	N	NEQSEC33R27ET3N	11/18/81	/ /	DWP,DISPERSED
MURPHY(510)	N	SEQSEC24R26ET4N	08/04/68	/ /	LEE DATA
MUTT 'N	SE	SWQSEC31R28ET2N	07/14/82	/ /	DWP,NOT FOUND
MV SUB 1(401)	NW	S1/2SEC20R26ET2N	05/05/68	/ /	LEE DATA
MV SUB 4(409)	NW	S1/2SEC20R26ET2N	05/07/68	/ /	LEE DATA
MV SUB 6(517)	NW	S1/2SEC20R26ET2N	08/30/68	/ /	LEE DATA
MV SUB 7(408)	NW	S1/2SEC20R26ET2N	05/07/68	/ /	LEE DATA
NONAME	SE	SWQSEC6R28ET1N	07/13/82	/ /	DWP,DISPERSED
NOVA	NE	NEQSEC12R27ET2N	07/14/82	/ /	DWP,NOT FOUND
OJO NEGRO	N	SWQSEC33R27ET3N	11/18/81	08/21/84	DWP,SUBMERGED
PAOHA 1(502,07)	ISL	NEQSEC32R27ET2N	06/21/68	/ /	LEE DATA
PAOHA 2	ISL	NEQSEC32R27ET2N	08/02/68	/ /	LEE DATA
PAOHA 3(506)	ISL	SEQSEC20R27ET2N	08/02/68	/ /	LEE DATA
PAOHA 4	ISL	NEQSEC29R27ET2N	08/02/68	/ /	LEE DATA
PAOHA 5(508)	ISL	NWQSEC32R27ET2N	08/02/68	/ /	LEE DATA
PEBBLE	N	NEQSEC17R28ET2N	07/14/82	08/19/86	DWP
PERSEVERANCE	N	NWQSEC12R26ET2N	11/19/81	10/03/85	DWP,SUBMERGED
RANCHERA(509)	N	SEQSEC20R26ET3N	07/31/68	/ /	LEE DATA
RANCHRIA GULCH1	N	NWQSEC20R26ET3N	08/05/80	/ /	BLM DATA
RANCHRIA GULCH2	N	NWQSEC20R26ET3N	08/05/80	/ /	BLM DATA
RANCHRIA GULCH3	N	NWQSEC20R26ET3N	08/05/80	/ /	BLM DATA
RANCHRIA GULCH4	N	NWQSEC20R26ET3N	08/05/80	/ /	BLM DATA
RATTLSNAK/BACON	N	NEQSEC31R26ET3N	08/05/80	/ /	BLM DATA
ROCK 'N	SW	NEQSEC5R26ET1N	10/02/85	08/20/86	DWP
ROLL	SW	NEQSEC5R26ET1N	10/02/85	08/20/86	DWP
SAMMON(216)	SE	NWQSEC7R28ET1N	11/13/67	09/21/83	LEE,NOW DWP,DR
SAND FLAT	SE	NEQSEC15R27ET1N	01/19/81	08/19/86	DWP
SANDPIPER CHNL	SE	NWQSEC6R28ET1N	07/13/82	08/19/86	DWP
SCORIA T T	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DRY
SEEPING	N	NWQSEC5R27ET2N	11/18/81	08/21/84	DWP,SUBMERGED
SESHOR1(302)	SE	NWQSEC12R27ET1N	02/21/68	03/18/82	LEE DATA
SHRIMP FARM	W	NEQSEC30R26ET2N	08/24/82	08/19/86	DWP
SNOWMELT MRSH	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
SO COMFRT HOT	S	SEQSEC17R27ET1N	02/17/82	10/02/85	DWP
SOFULL	W	NEQSEC4R26ET1N	09/20/83	/ /	DWP,SUBMERGED
SOLO HOT T T	N	NEQSEC12R26ET2N	11/19/81	08/21/84	DWP,SUBMERGED
SOLO TT(501)	N	NEQSEC12R26ET2N	06/21/68	/ /	LEE DATA
SPONGE MARSH	N	SEQSEC33R27ET3N	11/19/81	/ /	DWP,DISPERSED

APPENDIX C (cont.)

MONO BASIN SPRINGS

Alphabetical Listing

SPRING NAME	SUB-AREA	LOCATION	FIRST DATE of MEAS.	LAST DATE of MEAS.	COMMENTS
SPRG SE CORNER	SE		11/15/56	/ /	FETH DATA
SPRG W END	W		09/20/57	/ /	FETH DATA
SPYGLASS	NW	SWQSEC21R26ET2N	07/21/83	08/19/86	DWP
SULPHUR POND	N	SWQSEC26R27ET3N	09/03/80	/ /	BLM DATA
SUNSET 1	NW	SEQSEC19R26ET2N	02/16/82	10/01/85	DWP,SUBMERGED
SUNSET 2	NW	SEQSEC19R26ET2N	02/16/82	10/01/85	DWP,SUBMERGED
SUNSET 3	NW	SEQSEC19R26ET2N	02/16/82	10/01/85	DWP,SUBMERGED
SWLD TUFA MRSH	SE	NWQSEC6R28ET1N	07/13/82	/ /	DWP,DISPERSED
TEAL	SE	SEQSEC1R27ET1N	01/19/81	08/19/86	DWP
TERMINAL CHNL	SE	NEQSEC1R27ET1N	07/13/82	09/21/83	DWP,SUBMERGED
TIOGA LODGE	W	NEQSEC31R26ET2N	07/14/82	08/26/82	DWP,DISPERSED
TRINITY	SE	NWQSEC6R28ET1N	07/14/82	08/19/86	DWP
TWIN WARM	E	NEQSEC17R28ET2N	07/14/82	08/19/86	DWP
UNAMED	SE	NEQSEC15R27ET1N	03/18/82	/ /	DWP,DRY
UNNAMED W030	NW	NEQSEC24R25ET2N	08/03/80	/ /	BLM DATA
UNNAMED W031	NW	NEQSEC2R25ET2N	08/03/80	/ /	BLM DATA
UPPR MONO DIGGN	N	NWQSEC30R26ET3N	08/04/80	/ /	BLM DATA
VILLETTE	NW	NWQSEC20R26ET2N	01/01/36	08/18/86	DWP
VRJ	N	SWQSEC33R27ET3N	11/18/81	07/15/82	DWP,SUBMERGED
W.LV DELTA 1	SW	NWQSEC4R26ET1N	05/27/81	/ /	DWP,DISPERSED
W.LV DELTA 2	SW	NWQSEC4R26ET1N	05/27/81	/ /	DWP,DISPERSED
WAFORD(518)	N	NWQSEC28R27ET3N	06/01/69	/ /	LEE DATA
WARM SPRGS B	E	SEQSEC17R28ET2N	01/10/80	08/19/86	DWP
WATERCRESS	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WBURKHAM(307)	N	SWQSEC10R27ET3N	02/22/68	/ /	LEE DATA
WEARY	SE	SWQSEC6R28ET1N	07/13/82	/ /	DWP,DRY
WILLOW 0	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 1	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 2	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 3	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 4	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 5	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 6	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILLOW 7	NW	SEQSEC19R26ET2N	02/16/82	/ /	DWP,NOT FOUND
WILSON CRK SPRG	NW	NEQSEC2R25ET2N	08/04/80	/ /	BLM DATA
WLSN CK T STM1	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK T STM2	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK T STM3	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK TUFA1	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK TUFA2	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK TUFA3	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK TUFA4	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WLSN CK TUFA5	NW	SWQSEC21R26ET2N	05/28/81	/ /	DWP,DISPERSED
WMSPG MRSHCHNL	E	SEQSEC17R28ET2N	08/25/82	08/19/86	DWP
WRMSPRG 1	E	SEQSEC17R28ET2N	11/13/67	/ /	LEE DATA
WRMSPRG 2	E	SEQSEC17R28ET2N	11/13/67	/ /	LEE DATA

APPENDIX C (cont.)

MONO BASIN SPRINGS

Alphabetical Listing

SPRING NAME	SUB-AREA	LOCATION	FIRST DATE of MEAS.	LAST DATE of MEAS.	COMMENTS
WRMSPRG 3(215)	E	SEQSEC17R28ET2N	11/13/67	/ /	LEE DATA
WRMSPRG 4(303)	E	NEQSEC17R28ET2N	02/21/68	/ /	LEE DATA
WSHORE1(207)	W	NWQSEC5R26ET1N	11/11/67	/ /	LEE DATA
WSHORE2(208)	W	SWQSEC32R26ET2N	11/12/67	/ /	LEE DATA
WSHORE3	W	SWQSEC31R26ET2N	11/12/67	/ /	LEE DATA
WSHORE4	W	SWQSEC31R26ET2N	11/12/67	/ /	LEE DATA
WSHORE5(209)	W	NWQSEC32R26ET2N	11/12/67	/ /	LEE DATA
WSHORE6-14	W	SEQSEC30R26ET2N	11/14/67	/ /	LEE DATA

Appendix D

APPENDIX D

Area/Capacity - Mono Lake

Lake Elevation (feet)	Lake Area (acres)	Lake Area (sq.miles)	Lake Capacity Increment Storage (acre ft)	Lake Capacity Total Storage (acre ft)	Submerged Hard Substrate (acres)	Island Area (acres)
6226	0.	0.0	0.	0.	0.	N/A
6227	0.	0.0	0.	0.	0.	
6228	0.	0.0	0.	0.	0.	
6229	2.	0.0	1.	1.	0.	
6230	3.	0.0	2.	3.	0.	
6231	4.	0.0	4.	7.	0.	
6232	6.	0.0	5.	12.	0.	
6233	8.	0.0	7.	19.	0.	
6234	10.	0.0	9.	29.	0.	
6235	13.	0.0	11.	40.	1.	
6236	20.	0.0	16.	57.	1.	
6237	25.	0.0	23.	80.	2.	
6238	29.	0.0	27.	107.	2.	
6239	35.	0.1	32.	139.	2.	
6240	41.	0.1	37.	176.	3.	
6241	50.	0.1	45.	221.	3.	
6242	63.	0.1	57.	278.	3.	
6243	78.	0.1	71.	349.	4.	
6244	95.	0.1	86.	435.	5.	
6245	113.	0.2	103.	537.	6.	
6246	132.	0.2	123.	660.	6.	
6247	150.	0.2	141.	801.	7.	
6248	176.	0.3	163.	964.	8.	
6249	201.	0.3	189.	1153.	9.	
6250	225.	0.4	213.	1366.	10.	
6251	253.	0.4	238.	1605.	11.	
6252	303.	0.5	274.	1879.	13.	
6253	370.	0.6	335.	2214.	13.	
6254	468.	0.7	420.	2634.	15.	
6255	581.	0.9	521.	3156.	16.	
6256	711.	1.1	644.	3800.	18.	
6257	850.	1.3	781.	4581.	20.	
6258	1016.	1.6	929.	5510.	22.	
6259	1197.	1.9	1108.	6618.	24.	

FROM: PELAGOS CORP., FEB. 1987

Lake Elevation (feet)	Lake Area		Lake Capacity		Submerged Hard Substrate (acres)	Island Area (acres)
	(acres)	(sq.miles)	Increment Storage (acre ft)	Total Storage (acre ft)		
6260	1408.	2.2	1302.	7920.	27.	N/A
6261	1636.	2.6	1519.	9439.	31.	
6262	1854.	2.9	1749.	11188.	33.	
6263	2066.	3.2	1960.	13148.	38.	
6264	2278.	3.6	2170.	15318.	43.	
6265	2491.	3.9	2383.	17701.	49.	
6266	2755.	4.3	2622.	20322.	55.	
6267	3013.	4.7	2884.	23206.	62.	
6268	3286.	5.1	3145.	26351.	66.	
6269	3565.	5.6	3427.	29778.	71.	
6270	3881.	6.1	3722.	33500.	76.	
6271	4174.	6.5	4029.	37530.	80.	
6272	4452.	7.0	4316.	41846.	85.	
6273	4717.	7.4	4584.	46430.	91.	
6274	5003.	7.8	4858.	51288.	97.	
6275	5275.	8.2	5143.	56432.	103.	
6276	5551.	8.7	5413.	61844.	109.	
6277	5821.	9.1	5683.	67527.	115.	
6278	6111.	9.5	5968.	73495.	121.	
6279	6367.	9.9	6239.	79735.	126.	
6280	6606.	10.3	6485.	86220.	130.	
6281	6872.	10.7	6739.	92959.	136.	
6282	7166.	11.2	7011.	99970.	141.	
6283	7536.	11.8	7344.	107314.	146.	
6284	7907.	12.4	7725.	115039.	152.	
6285	8305.	13.0	8101.	123140.	158.	
6286	8717.	13.6	8509.	131649.	165.	
6287	9156.	14.3	8927.	140576.	170.	
6288	9602.	15.0	9380.	149956.	178.	
6289	10033.	15.7	9820.	159776.	186.	
6290	10477.	16.4	10250.	170026.	196.	
6291	10904.	17.0	10689.	180715.	208.	
6292	11341.	17.7	11121.	191835.	218.	
6293	11778.	18.4	11561.	203397.	230.	
6294	12194.	19.1	11989.	215386.	241.	
6295	12637.	19.7	12418.	227804.	254.	
6296	13076.	20.4	12851.	240654.	268.	
6297	13510.	21.1	13303.	253957.	284.	
6298	13922.	21.8	13712.	267668.	303.	
6299	14300.	22.3	14114.	281783.	320.	

APPENDIX D

Lake Elevation (feet)	Lake Area (acres)	Lake Area (sq.miles)	Lake Capacity Increment Storage (acre ft)	Lake Capacity Total Storage (acre ft)	Submerged Hard Substrate (acres)	Island Area (acres)
6300	14658.	22.9	14483.	296266.	336.	136.
6301	15019.	23.5	14837.	311103.	347.	128.
6302	15374.	24.0	15195.	326298.	363.	142.
6303	15741.	24.6	15552.	341850.	373.	164
6304	16175.	25.3	15950.	357800.	384.	165.
6305	16581.	25.9	16387.	374187.	399.	132.
6306	16919.	26.4	16752.	390938.	413.	113.
6307	17258.	27.0	17084.	408022.	431.	74.
6308	17552.	27.4	17403.	425425.	455.	94.
6309	17884.	27.9	17727.	443152.	485.	198.
6310	18172.	28.4	18028.	461180.	514.	576.
6311	18447.	28.8	18310.	479490.	542.	631.
6312	18745.	29.3	18599.	498088.	567.	600.
6313	19045.	29.8	18895.	516984.	595.	550.
6314	19356.	30.2	19202.	536186.	626.	555.
6315	19670.	30.7	19512.	555697.	660.	589.
6316	19975.	31.2	19824.	575522.	694.	466.
6317	20289.	31.7	20135.	595657.	728.	416.
6318	20623.	32.2	20456.	616113.	765.	334.
6319	20943.	32.7	20783.	636896.	803.	294.
6320	21263.	33.2	21109.	658005.	843.	298.
6321	21561.	33.7	21417.	679422.	882.	280.
6322	21833.	34.1	21699.	701121.	924.	232.
6323	22103.	34.5	21971.	723092.	965.	190.
6324	22360.	34.9	22231.	745323.	1005.	165.
6325	22627.	35.4	22493.	767816.	1049.	137.
6326	22888.	35.8	22755.	790572.	1094.	142.
6327	23156.	36.2	23022.	813594.	1144.	180.
6328	23424.	36.6	23290.	836884.	1194.	192.
6329	23687.	37.0	23561.	860445.	1252.	181.
6330	23926.	37.4	23805.	884250.	1294.	163.
6331	24172.	37.8	24048.	908298.	1338.	157.
6332	24436.	38.2	24304.	932602.	1388.	147.
6333	24695.	38.6	24569.	957171.	1432.	136.
6334	24964.	39.0	24832.	982003.	1478.	122.
6335	25247.	39.4	25109.	1007112.	1528.	116.
6336	25516.	39.9	25379.	1032490.	1581.	117.
6337	25800.	40.3	25661.	1058151.	1638.	135.
6338	26100.	40.8	25958.	1084109.	1711.	149.
6339	26387.	41.2	26249.	1110358.	1782.	196.

APPENDIX D

Lake Elevation (feet)	Lake Area		Lake Capacity		Submerged Hard Substrate (acres)	Island Area (acres)
	(acres)	(sq.miles)	Increment Storage (acre ft)	Total Storage (acre ft)		
6340	26673.	41.7	26532.	1136890.	1850.	195.
6341	26958.	42.1	26814.	1163704.	1924.	193.
6342	27277.	42.6	27117.	1190822.	2007.	186.
6343	27599.	43.1	27437.	1218259.	2083.	267.
6344	27926.	43.6	27766.	1246024.	2163.	280.
6345	28222.	44.1	28077.	1274101.	2241.	229.
6346	28505.	44.5	28364.	1302466.	2316.	192.
6347	28790.	45.0	28644.	1331110.	2399.	172.
6348	29074.	45.4	28928.	1360039.	2508.	165.
6349	29327.	45.8	29202.	1389241.	2600.	1110.
6350	29583.	46.2	29455.	1418695.	2703.	2616.
6351	29838.	46.6	29714.	1448409.	2815.	2586.
6352	30088.	47.0	29962.	1478371.	2948.	2559.
6353	30333.	47.4	30216.	1508587.	3077.	2558.
6354	30568.	47.8	30450.	1539037.	3210.	2558.
6355	30801.	48.1	30687.	1569724.	3349.	2543.
6356	31036.	48.5	30918.	1600642.	3495.	2520.
6357	31284.	48.9	31157.	1631799.	3662.	2498.
6358	31543.	49.3	31414.	1663213.	3850.	2485.
6359	31833.	49.7	31689.	1694902.	4070.	2515.
6360	32148.	50.2	31992.	1726895.	4314.	2490.
6361	32449.	50.7	32299.	1759194.	4555.	2464.
6362	32763.	51.2	32605.	1791799.	4817.	2446.
6363	33057.	51.7	32908.	1824707.	5068.	2418.
6364	33367.	52.1	33211.	1857918.	5329.	2393.
6365	33673.	52.6	33520.	1891437.	5595.	2367.
6366	33979.	53.1	33825.	1925262.	5865.	2348.
6367	34274.	53.6	34125.	1959388.	6140.	2325.
6368	34625.	54.1	34443.	1993831.	6475.	2305.
6369	35119.	54.9	34857.	2028688.	6959.	2299
6370	35674.	55.7	35415.	2064103.	7505.	2272.
6371	36082.	56.4	35883.	2099986.	7904.	2243.
6372	36489.	57.0	36272.	2136257.	8299.	2243.
6373	37962.	59.3	36820.	2173078.	9752.	2728.
6374	39106.	61.1	38705.	2211783.	10886.	2439.
6375	40509.	63.3	39459.	2251242.	12284.	2651.
6376	41489.	64.8	41162.	2292404.		
6377	41957.	65.6	41737.	2334141.		
6378	42361.	66.2	42165.	2376306.		
6379	42746.	66.8	42542.	2418847.		

APPENDIX D

Lake Elevation (feet)	Lake Area (acres)	Lake Area (sq.miles)	Lake Capacity Increment Storage (acre ft)	Lake Capacity Total Storage (acre ft)	Submerged Hard Substrate (acres)	Island Area (acres)
6380	43996.	68.7	42966.	2461813.		2655.
6381	44675.	69.8	44474.	2506288.		
6382	45026.	70.4	44857.	2551145.		
6383	45350.	70.9	45191.	2596336.		
6384	45665.	71.4	45501.	2641837.		
6385	46444.	72.6	45855.	2687691.		2302.
6386	47018.	73.5	46806.	2734498.		
6387	47332.	74.0	47183.	2781681.		
6388	47605.	74.4	47468.	2829149.		
6389	47870.	74.8	47738.	2876887.		
6390	48290.	75.5	48014.	2924901.		2016.
6391	48687.	76.1	48521.	2973422.		
6392	48969.	76.5	48835.	3022257.		
6393	49223.	76.9	49101.	3071358.		
6394	49460.	77.3	49341	3120699.		
6395	49842.	77.9	49602.	3170301.		1835.
6396	50173.	78.4	50032.	3220333.		
6397	50422.	78.8	50300.	3270632.		
6398	50648.	79.1	50538.	3321171.		
6399	50875	79.5	50759.	3371930.		
6400	51219.	80.0	51006.	3422936.		1703.
6401	51571.	80.6	51423.	3474359.		
6402	51792.	80.9	51685.	3526043.		
6403	51999.	81.2	51900.	3577943.		
6404	52199	81.6	52098.	3630041.		
6405	52476.	82.0	52321.	3682362.		1573
6406	52758.	82.4	52639.	3735001.		
6407	52950.	82.7	52855.	3787856.		
6408	53131.	83.0	53042.	3840898.		
6409	53300	83.3	53214.	3894113.		
6410	53539.	83.7	53395.	3947508.		1514.
6411	53803.	84.1	53692.	4001200.		
6412	53971.	84.3	53890.	4055090.		
6413	54143.	84.6	54060.	4109150.		
6414	54289.	84.8	54215.	4163365.		
6415	54500.	85.2	54372.	4217737.		1470.
6416	54756.	85.6	54643.	4272380.		
6417	54926.	85.8	54843.	4327224.		
6418	55098.	86.1	55013.	4382237.		
6419	55253.	86.3	55174.	4437411.		

APPENDIX D

Lake Elevation (feet)	Lake Area (acres)	Lake Area (sq.miles)	Lake Capacity Increment Storage (acre ft)	Lake Capacity Total Storage (acre ft)	Submerged Hard Substrate (acres)	Island Area (acres)
6420	55507.	86.7	55350.	4492761.		1439.
6421	55769.	87.1	55659.	4548420.		
6422	55932.	87.4	55853.	4604273.		
6423	56102.	87.7	56015.	4660289.		
6424	56294.	88.0	56197.	4716485.		
6425	56632.	88.5	56419.	4772904.		1406.
6426	56918.	88.9	56800.	4829704.		
6427	57145.	89.3	57030.	4886734.		
6428	57422.	89.7	57274.	4944008.		
6429	57771.	90.3	57584.	5001592.		
6430	58635.	91.6	58016.	5059608.		1406.

Appendix E

APPENDIX E

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.
1912	
June 15	6423.40
July 3	6423.36
Aug. 3	6423.34
Sept. 11	6422.88
Oct. 11	6422.68
Nov. 5	6422.46
Dec. 3	6422.44
1913	
Apr. 16	6422.54
May 15	6422.46
June 29	6422.84
Aug. 25	6422.70
Sept. 14	6422.66
Oct. 12	6422.34
Dec. 11	6422.08
1914	
Jan. 4	6422.30
Feb. 7	6422.84
Mar. 30	6423.18
May 9	6423.50
June 13	6424.02
July 8	6424.74
Aug. 9	6425.10
Sept. 13	6424.60
Oct. 4	6424.48
Dec. 30	6424.20
1915	
Jan. 26	6424.24
Feb. 25	6424.70
Mar. 12	6424.74
Apr. 10	6424.86
May 4	6426.84
1916	
July 13	6426.14
Aug. 23	6425.94
Sept. 28	6425.64
Nov. 20	6425.54
1917	
Apr. 15	6425.94
May 4	6426.00
June 15	6426.24
July 10	6426.50
Aug. 23	6426.56
Sept. 26	6425.94
Oct. 18	6425.84
Nov. 11	6425.80
Dec. 4	6425.69
1918	
Apr. 21	6426.48
May 10	6426.44
June 16	6426.60
July 8	6426.94
Aug. 20	6426.54
Sept. 22	6426.24
Oct. 16	6426.34
1919	
Apr. 24	6427.14
May 27	6427.34
June 23	6427.50
July 18	6427.70
Aug. 20	6427.04
Sept. 25	6426.44
Oct. 15	6426.34
Nov. 8	6426.14
Dec. 9	6426.14
1920	
Apr. 7	6426.64
May 22	6426.64
June 28	6426.50
July 19	6426.34
Aug. 24	6425.84
Sept. 28	6425.54
Oct. 20	6425.40
Nov. 19	6425.24
1921	
Apr. 15	6425.74
May 16	6425.74
June 23	6425.94
July 16	6426.04
Aug. 17	6425.54
Sept. 15	6425.40
Oct. 20	6425.24
Nov. 20	6425.14
Dec. 15	6425.10
1922	
May 13	6425.94
June 24	6426.40
July 20	6426.34
Aug. 25	6426.24
Sept. 27	6425.94
Oct. 31	6425.80
1923	
Mar. 28	6426.44
Apr. 24	6426.54
May 20	6426.50
June 29	6426.60
July 30	6426.60
Aug. 15	6426.44
Sept. 18	6426.14
Oct. 10	6426.04

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.
1923 (Cont'd)	
Nov. 7	6425.80
Dec. 7	6425.74
1924	
Apr. 5	6426.04
May 9	6426.10
June 26	6425.74
July 25	6425.34
Aug. 20	6425.04
Sept. 20	6424.84
Oct. 20	6424.44
Nov. 18	6424.24
Dec. 10	6424.34
1925	
Apr. 14	6424.44
May 23	6424.54
June 16	6424.44
July 18	6424.54
Aug. 25	6424.14
Sept. 20	6423.44
Oct. 17	6423.68
Nov. 17	6423.60
Dec. 15	6423.68
1926	
Jan. 4	6423.82
Feb. 1	6423.92
Mar. 17	6424.11
Apr. 5	6424.16
May 18	6424.22
June 17	6424.20
July	6424.14
Aug. 16	6423.71
Sept. 6	6423.36
Oct. 15	6422.86
Nov. 10	6422.91
Dec. 3	6423.06
1927	
Jan. 1	6423.10
Mar. 21	6423.52
Apr. 28	6523.54
May 14	6423.50
June 11	6423.51
July 27	6423.60
Aug. 13	6423.37
Sept. 14	6423.01
Oct. 6	6422.83
Dec. 8	6422.87
1928	
Jan. 12	6422.84
Feb. 2	6422.85
Mar. 8	6423.10
Apr. 7	6423.20
May 13	6423.20
June 6	6423.29
July 8	6422.96
Aug. 19	6422.52
Sept. 22	6422.10
Oct. 15	6421.90
Nov. 8	6421.80
1929	
Jan. 10	6421.77
Apr. 18	6421.85
May 3	6421.89
June 6	6421.73
July 5	6421.74
Aug. 1	6421.57
Sept. 20	6420.89
Oct. 3	6420.69
Nov. 1	6420.56
Dec. 2	6420.45
1930	
Apr. 9	6420.51
May 8	6420.44
June 5	6420.37
July 3	6420.32
1930 (Cont'd)	
Aug. 7	6419.99
Sept. 25	6419.29
Oct. 2	6419.42
Nov. 6	6419.25
Dec. 2	6419.18
1931	
Jan. 20	6419.15
Feb. 6	6419.18
Mar. 3	6419.18
Apr. 16	6419.20
May 10	6419.19
June 9	6419.11
July 3	6418.91
Aug. 6	6418.56
Sept. 10	6418.12
Oct. 8	6417.87
Nov. 5	6417.66
Dec. 3	6417.50
1932	
Apr. 28	6418.09
May 12	6418.08
June 3	6418.09
July 4	6418.15
Aug. 3	6418.00
Sept. 1	6417.63
Oct. 6	6417.47
Nov. 3	6417.19
Dec. 4	6417.21
1933	
Apr. 8	6417.39
May 5	6417.27
June 7	6417.21
July 7	6417.19
Aug. 2	6417.04
Sept. 8	6416.44
Oct. 4	6416.12
Nov. 7	6415.96

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.
1933 (Cont'd)	
Dec. 6	6415.89
1934	
Jan. 26	6416.08
Feb. 5	6416.09
Mar. 6	6416.22
Apr. 3	6416.29
May 4	6416.21
June 1	6416.04
July 3	6416.09
Aug. 7	6415.67
Sept. 1	6415.40
Oct. 2	6414.93
Nov. 2	6414.74
Dec. 7	6414.64
1935	
Jan. 1	6414.70
Feb. 6	6414.90
Mar. 9	6415.04
Apr. 5	6415.13
May 3	6415.22
June 1	6415.18
July 2	6415.21
Aug. 1	6415.07
Sept. 2	6414.82
Oct. 2	6414.52
Nov. 18	6414.14
Dec. 4	6414.23
1936	
Jan. 7	6414.45
Feb. 6	6414.64
Mar. 4	6414.97
Apr. 2	6415.06
May 8	6415.09
June 4	6415.01
July 10	6415.07
Aug. 4	6415.07
1936 (Cont'd)	
Sept. 8	6414.79
Oct. 2	6414.67
Nov. 5	6414.53
Dec. 3	6414.50
1937	
Jan. 2	6414.57
Feb. 3	6414.64
Mar. 3	6415.05
Apr. 2	6415.20
May 4	6415.24
June 4	6415.33
July 1	6415.39
Aug. 2	6415.29
Sept. 4	6414.99
Oct. 2	6414.59
Nov. 1	6414.44
Dec. 7	6414.34
1938	
Jan. 4	6414.59
Feb. 10	6414.72
Mar. 2	6415.20
Apr. 5	6415.81
May 6	6416.12
June 1	6416.55
July 1	6417.14
Aug. 4	6417.79
Sept. 6	6417.83
Oct. 3	6417.67
Nov. 7	6417.65
Dec. 5	6417.73
1939	
Jan. 3	6417.94
Feb. 9	6418.10
Mar. 10	6418.17
Apr. 1	6418.38
1939 (Cont'd)	
May 3	6418.44
June 6	6418.29
July 1	6418.21
Aug. 2	6417.96
Sept. 5	6417.51
Oct. 3	6417.29
Nov. 6	6417.02
Dec. 4	6416.94
1940	
Jan. 2	6416.89
Feb. 5	6417.11
Mar. 4	6417.31
Apr. 1	6417.41
May 8	6417.36
June 3	6417.41
July 1	6417.50
Aug. 7	6417.16
Sept. 4	6416.77
Oct. 3	6416.55
Nov. 4	6416.32
Dec. 5	6416.25
1941	
Jan. 1	6416.56
Feb. 4	6416.66
Mar. 5	6416.90
Apr. 1	6416.87
May 1	6416.94
June 3	6416.95
July 10	6417.20
Aug. 5	6417.24
Sept. 3	6416.94
Oct. 4	6416.59
Nov. 3	6416.64
Dec. 1	6416.51

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.	DATE	ELEV. W.S.	DATE	ELEV. W.S.
1942		1945		1948	
Jan. 3	6416.81	Jan. 1	6415.96	Jan. 1	6415.31
Feb. 7	6416.99	Feb. 12	6416.30	Feb. 5	6415.36
Mar. 2	6417.02	Mar. 3	6416.32	Mar. 4	6415.31
Apr. 7	6417.19	Apr. 6	6416.36	Apr. 5	6415.30
May 5	6417.37	May 4	6416.40	May 5	6415.24
June 4	6417.40	June 1	6416.63	June 2	6415.11
July 3	6417.48	July 3	6416.94	July 2	6414.96
Aug. 4	6417.58	Aug. 7	6417.09	Aug. 4	6414.60
Sept. 2	6417.35	Sept. 7	6417.00	Sept. 2	6414.07
Oct. 2	6417.12	Oct. 2	6416.79	Oct. 1	6413.69
Nov. 2	6416.87	Nov. 2	6416.78	Nov. 2	6413.45
Dec. 3	6416.77	Dec. 18	6416.71	Dec. 1	6413.13
1943		1946		1949	
Jan. 4	6416.77	Jan. 9	6417.00	Jan. 5	6413.22
Feb. 3	6417.32	Feb. 5	6417.14	Feb. 9	6413.23
Mar. 4	6417.49	Mar. 12	6417.26	Mar. 2	6413.23
Apr. 1	6417.64	Apr. 2	6417.53	Apr. 6	6413.25
May 7	6417.77	May 6	6417.69	May 4	6413.16
June 4	6417.83	June 6	6417.57	June 2	6413.08
July 3	6417.89	July 5	6417.40	July 6	6412.73
Aug. 2	6418.07	Aug. 5	6417.26	Aug. 3	6412.41
Sept. 2	6417.89	Sept. 3	6416.96	Sept. 1	6412.01
Oct. 1	6417.68	Oct. 4	6416.56	Oct. 4	6411.50
Nov. 1	6417.23	Nov. 8	6416.46	Nov. 8	6411.25
Dec. 7	6417.19	Dec. 2	6416.76	Dec. 6	6411.26
1944		1947		1950	
Jan. 3	6417.17	Jan. 7	6417.09	Jan. 6	6411.04
Feb. 1	6417.27	Feb. 7	6417.26	Feb. 6	6411.16
Mar. 1	6417.44	Mar. 7	6417.51	Mar. 7	6411.17
Apr. 5	6417.55	Apr. 1	6417.66	Apr. 10	6411.16
May 1	6417.56	May 2	6417.63	May 9	6410.97
June 1	6417.50	June 3	6417.41	June 9	6410.80
July 4	6417.34	July 9	6417.06	July 6	6410.58
Aug. 1	6417.09	Aug. 4	6416.68	Aug. 2	6410.32
Sept. 1	6416.64	Sept. 2	6416.23	Sept. 6	6409.90
Oct. 3	6416.21	Oct. 3	6415.96	Oct. 2	6409.69
Nov. 3	6416.06	Nov. 7	6415.56	Nov. 3	6409.37
Dec. 12	6415.94	Dec. 2	6415.39	Dec. 7	6409.57

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.	DATE	ELEV. W.S.	DATE	ELEV. W.S.
1951		1954		1957	
Jan. 5	6409.67	Jan. 6	6406.68	Jan. 4	6401.68
Feb. 8	6409.54	Feb. 4	6406.71	Feb. 8	6401.92
Mar. 12	6409.45	Mar. 4	6406.82	Mar. 1	6402.15
Apr. 2	6409.40	Apr. 2	6406.86	Apr. 8	6402.23
May 5	6409.33	May 6	6406.72	May 3	6402.23
June 7	6409.14	June 2	6406.50	June 7	6402.19
July 6	6408.93	July 1	6406.23	July 10	6401.95
Aug. 2	6408.68	Aug. 6	6405.83	Aug. 2	6401.61
Sept. 6	6408.15	Sept. 3	6405.29	Sept. 6	6401.07
Oct. 5	6407.76	Oct. 1	6404.91	Oct. 4	6400.73
Nov. 2	6407.52	Nov. 5	6404.61	Nov. 1	6400.57
Dec. 10	6407.47	Dec. 3	6404.47	Dec. 6	6400.52
1952		1955		1958	
Jan. 4	6407.54	Jan. 7	6404.43	Jan. 3	6400.65
Feb. 4	6407.64	Feb. 8	6404.42	Feb. 5	6400.69
Mar. 21	6407.82	Mar. 9	6404.40	Mar. 7	6400.94
Apr. 3	6407.85	Apr. 8	6404.41	Apr. 7	6401.26
May 5	6408.04	May 6	6404.27	May 1	6401.40
June 2	6408.31	June 3	6404.15	June 6	6401.59
July 7	6408.43	July 1	6403.89	July 3	6401.70
Aug. 5	6408.92	Aug. 5	6403.60	Aug. 1	6401.81
Sept. 8	6408.50	Sept. 2	6403.22	Sept. 5	6401.55
Oct. 2	6408.36	Oct. 7	6402.77	Oct. 3	6401.18
Nov. 6	6408.18	Nov. 4	6402.48	Nov. 7	6400.94
Dec. 4	6408.16	Dec. 2	6402.34	Dec. 5	6400.83
1953		1956		1959	
Jan. 9	6408.33	Jan. 6	6402.75	Jan. 8	6400.84
Feb. 6	6408.54	Feb. 3	6402.87	Feb. 6	6400.87
Mar. 5	6408.55	Mar. 2	6402.79	Mar. 6	6401.04
Apr. 2	6408.69	Apr. 6	6402.69	Apr. 2	6401.14
May 7	6408.65	May 4	6402.79	May 1	6401.15
June 4	6408.49	June 1	6402.68	June 5	6400.94
July 2	6408.30	July 6	6402.46	July 3	6400.67
Aug. 7	6407.95	Aug. 3	6402.43	Aug. 7	6400.21
Sept. 2	6407.49	Sept. 7	6402.10	Sept. 4	6399.72
Oct. 1	6407.23	Oct. 5	6401.73	Oct. 2	6399.42
Nov. 6	6406.99	Nov. 2	6401.59	Nov. 2	6399.18
Dec. 3	6406.73	Dec. 7	6401.58	Dec. 7	6398.91

MONO BASIN

MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.	DATE	ELEV. W.S.	DATE	ELEV. W.S.
1960		1963		1966	
Jan. 5	6398.95	Jan. 2	6393.10	Jan. 3	6388.72
Feb. 8	6398.85	Feb. 6	6393.55	Feb. 7	6388.84
Mar. 7	6398.86	Mar. 4	6393.58	Mar. 11	6388.98
Apr. 4	6399.01	Apr. 5	6393.54	Apr. 7	6388.96
May 2	6398.80	May 6	6393.42	May 5	6388.75
June 6	6398.60	June 3	6393.37	June 10	6388.53
July 5	6398.27	July 1	6393.29	July 8	6388.13
Aug. 1	6398.03	Aug. 5	6392.99	Aug. 5	6387.86
Sept. 8	6397.40	Sept. 5	6392.58	Sept. 1	6387.41
Oct. 3	6397.22	Oct. 3	6392.36	Oct. 6	6387.03
Nov. 7	6397.04	Nov. 6	6392.05	Nov. 3	6386.80
Dec. 5	6396.92	Dec. 2	6391.94	Dec. 1	6386.58
1961		1964		1967	
Jan. 5	6396.90	Jan. 3	6391.90	Jan. 6	6386.72
Feb. 6	6396.92	Feb. 3	6391.83	Feb. 3	6386.96
Mar. 6	6396.86	Mar. 2	6391.93	Mar. 2	6386.91
Apr. 3	6396.81	Apr. 2	6391.94	Apr. 7	6387.04
May 1	6396.61	May 4	6391.68	May 2	6387.08
June 5	6396.49	June 1	6391.69	June 5	6387.14
July 3	6396.27	July 2	6391.36	July 3	6387.32
Aug. 7	6395.80	Aug. 3	6390.98	Aug. 3	6388.37
Sept. 7	6395.49	Sept. 8	6390.39	Sept. 7	6388.41
Oct. 2	6395.19	Oct. 1	6390.17	Oct. 5	6388.35
Nov. 7	6394.82	Nov. 2	6389.90	Nov. 2	6388.19
Dec. 4	6394.70	Dec. 7	6389.58	Dec. 1	6388.29
1962		1965		1968	
Jan. 2	6394.60	Jan. 7	6389.73	Jan. 4	6388.29
Feb. 5	6394.65	Feb. 1	6389.69	Feb. 8	6388.54
Mar. 5	6394.85	Mar. 5	6389.59	Mar. 7	6388.63
Apr. 4	6395.11	Apr. 5	6389.79	Apr. 5	6388.55
May 7	6394.95	May 3	6389.61	May 2	6388.41
June 4	6394.83	June 1	6389.46	June 6	6388.15
July 2	6394.67	July 1	6389.26	July 3	6387.89
Aug. 6	6394.29	Aug. 2	6389.12	Aug. 8	6387.52
Sept. 6	6393.87	Sept. 6	6388.84	Sept. 5	6387.09
Oct. 1	6393.63	Oct. 4	6388.68	Oct. 3	6386.78
Nov. 5	6393.33	Nov. 1	6388.58	Nov. 14	6386.50
Dec. 3	6393.20	Dec. 6	6388.56	Dec. 4	6386.38

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.	DATE	ELEV. W.S.	DATE	ELEV. W.S.
1969		1972		1975	
Jan. 2	6386.32	Jan. 6	6385.59	Jan. 9	6380.18
Feb. 5	6386.82	Feb. 17	6385.52	Feb. 7	6380.22
Mar. 5	6387.23	Mar. 1	6385.50	Mar. 6	6380.31
Apr. 1	6387.38	Apr. 4	6385.48	Apr. 4	6380.35
May 5	6387.95	May 1	6385.39	May 7	6380.32
June 2	6388.55	June 5	6385.20	June 4	6380.21
July 7	6389.26	July 6	6384.92	July 17	6379.73
Aug. 5	6389.65	Aug. 10	6384.49	Aug. 7	6379.45
Sept. 2	6389.41	Sept. 7	6384.18	Sept. 4	6379.12
Oct. 10	6389.02	Oct. 5	6383.96	Oct. 9	6378.96
Nov. 14	6388.82	Nov. 2	6383.71	Nov. 13	6378.89
Dec. 4	6388.80	Dec. 5	6383.61	Dec. 10	6378.73
1970		1973		1976	
Jan. 6	6388.80	Jan. 2	6383.57	Jan. 9	6378.69
Feb. 2	6389.17	Feb. 1	6383.69	Feb. 10	6378.73
Mar. 2	6389.35	Mar. 7	6383.91	Mar. 8	6378.76
Apr. 2	6389.39	Apr. 5	6383.92	Apr. 1	6378.75
May 7	6389.19	May 2	6383.85	May 13	6378.59
June 2	6389.05	June 1	6383.72	June 3	6378.53
July 6	6388.79	July 2	6383.48	July 1	6378.09
Aug. 5	6388.51	Aug. 8	6383.08	Aug. 5	6377.83
Sept. 3	6388.08	Sept. 6	6382.67	Sept. 8	6377.49
Oct. 2	6387.65	Oct. 5	6382.39	Oct. 7	6377.32
Nov. 13	6387.27	Nov. 8	6382.06	Nov. 4	6377.15
Dec. 7	6387.40	Dec. 14	6382.09	Dec. 7	6376.75
1971		1974		1977	
Jan. 5	6387.34	Jan. 3	6382.14	Jan. 19	6376.57
Feb. 5	6387.39	Feb. 7	6382.31	Feb. 2	6376.48
Mar. 2	6387.34	Mar. 4	6382.32	Mar. 10	6376.61
Apr. 7	6387.34	Apr. 4	6382.28	Apr. 21	6376.51
May 7	6387.25	May 9	6382.08	May 12	6376.38
June 1	6387.17	June 6	6381.90	June 8	6376.27
July 7	6386.82	July 10	6381.40	July 11	6376.27
Aug. 5	6386.56	Aug. 1	6381.33	Aug. 4	6375.92
Sept. 7	6386.10	Sept. 10	6380.96	Sept. 8	6375.48
Oct. 4	6385.74	Oct. 11	6380.47	Oct. 6	6375.20
Nov. 4	6385.51	Nov. 20	6380.45	Nov. 8	6374.91
Dec. 6	6385.43	Dec. 5	6380.44	Dec. 30	6374.95

MONO BASIN
MONO LAKE WATER SURFACE ELEVATION - FEET

DATE	ELEV. W.S.
1978	
Jan. 20	6375.20
Mar. 3	6375.46
Apr. 12	6375.75
May 16	6375.66
June 2	6375.53
July 6	6375.34
Aug. 3	6375.24
Sept. 15	6375.29
Oct. 2	6374.61
Nov. 3	6374.53
Dec. 14	6374.32
1979	
Jan. 4	6374.36
Feb. 1	6374.49
Mar. 8	6374.57
Apr. 4	6374.71
May 1	6374.60
June 8	6374.34
July 6	6374.00
Aug. 2	6373.81
Sept. 6	6373.33
Oct. 4	6373.04
Nov. 5	6372.77
Dec. 6	6372.62
1980	
Jan. 8	6372.66
Feb. 5	6373.01
Mar. 5	6373.43
Apr. 2	6373.50
May 7	6373.87
June 5	6373.93
July 1	6373.81
Aug. 7	6373.96
Sept. 3	6373.72
Oct. 1	6373.50
Nov. 5	6373.29
Dec. 10	6373.20
1981	
Jan. 7	6373.24
Feb. 5	6373.41
Mar. 4	6373.56
Apr. 1	6373.56
May 6	6373.51
June 3	6373.37
July 1	6373.10
Aug. 5	6372.61
Sept. 2	6372.24
Oct. 7	6371.84
Nov. 4	6371.72
Dec. 2	6371.72
1982	
Jan. 6	6371.69
Feb. 4	6371.70
Mar. 3	6371.96
Apr. 8	6371.99
May 5	6372.15
June 2	6371.97
July 7	6372.03
Aug. 4	6372.31
Sept. 1	6372.39
Oct. 6	6372.50
Nov. 3	6372.87
Dec. 1	6373.24
1983	
Feb. 15	6374.52
Mar. 2	6375.04
Apr. 5	6375.60
May 4	6375.93
June 1	6376.20
July 6	6377.19
Aug. 3	6377.51
Sept. 7	6378.04
Oct. 5	6378.31
Nov. 2	6378.49
Dec. 1	6378.83
1984	
Jan. 5	6379.58
Feb. 1	6379.94
Mar. 7	6380.38
Apr. 4	6380.53
May 2	6380.48
June 6	6380.30
July 5	6380.04
Aug. 1	6379.91
Sept. 5	6379.88
Oct. 3	6379.71
Nov. 7	6379.43
Dec. 5	6379.42
1985	
Mar. 11	6379.77
Apr. 3	6379.80
May 2	6379.80
June 6	6379.49
July 3	6379.20
Aug. 1	6378.87
Sept. 5	6378.47
Oct. 3	6378.32
Nov. 7	6378.16
Dec. 5	6378.15
1986	
Jan. 16	6378.29
Feb. 6	6378.30
Mar. 6	6379.01
Apr. 3	6379.48
May 7	6379.81
June 4	6380.20
July 2	6380.48
Aug. 6	6380.62
Sept. 3	6380.31
Oct. 1	6379.85
Nov. 5	6379.71
Dec. 3	6379.61

Appendix F

MONO LAKE HYDROLOGIC MODEL (Historic Period 1941-85)

MONO LAKE MODEL

LOS ANGELES DEPARTMENT OF WATER AND POWER
AQUEDUCT DIVISION - GROUNDWATER SECTION

RUNDATE: 02-28-1987
TIME: 07:28:31

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
								SURFACE & SUBSURFACE			**** LAKE EVAPORATION *****					
WATER YEAR	MEASURED ELEV (ft)	CALC ELEV (ft)	MODEL DIFF (ft)	CALC VOLUME (acft)	CALC SURFACE AREA (acres)	LAKE INDX	PRECIP ANNUAL (acft)	INDX	W.PORT EXPORT (acft)	INFLOW (acft)	INDX	LAKE S.G.	EVAP ADJ.	ANNUAL (acft)	CHANGE IN STORAGE (acft)	TDS IN PPM
1940		6416.55		4302500	54850											
1940-41	6416.61	6417.20	-0.59	4338500	54850	1.26	46100	1.31	31200	167000	0.95	1.039	.971	177100	36000	46520
1941-42	6417.12	6418.17	-1.05	4391600	54960	0.93	34100	1.29	1600	192700	0.93	1.039	.971	173700	53100	45958
1942-43	6417.68	6418.85	-1.17	4429400	55120	0.91	33500	1.27	7400	184100	0.96	1.039	.971	179800	37800	45566
1943-44	6416.25	6417.29	-1.04	4343300	55230	0.72	26500	0.86	56000	75200	1.00	1.038	.972	187900	-86100	46514
1944-45	6416.79	6418.05	-1.26	4384800	54980	1.11	40700	1.15	12100	161500	0.86	1.039	.971	160700	41500	46029
1945-46	6416.60	6418.46	-1.86	4407400	55110	1.00	36800	1.05	0	158100	0.92	1.039	.971	172300	22600	45793
1946-47	6415.96	6417.64	-1.68	4362400	55170	0.98	36100	0.75	12400	100900	0.97	1.038	.972	182100	-45000	46310
1947-48	6413.69	6415.22	-1.53	4229500	55040	0.50	18400	0.76	77400	39400	1.02	1.039	.971	190800	-132900	47719
1948-49	6411.54	6412.81	-1.27	4098700	54560	0.78	28400	0.76	93200	24100	0.99	1.040	.970	183400	-130800	49195
1949-50	6409.70	6410.62	-0.92	3980700	54110	0.58	20900	0.78	94100	26200	0.90	1.041	.969	165200	-118000	50604
1950-51	6407.86	6409.08	-1.22	3898400	53700	1.08	38700	0.98	95000	55400	0.97	1.043	.968	176500	-82300	51574
1951-52	6408.36	6410.55	-2.19	3977100	53320	1.67	59400	1.37	28900	178300	0.88	1.043	.968	159000	78700	50553
1952-53	6407.23	6409.37	-2.14	3914100	53680	0.54	19300	0.87	64400	68600	0.83	1.043	.968	151000	-63000	51367
1953-54	6404.91	6407.34	-2.43	3806000	53390	0.72	25600	0.61	51700	41700	0.97	1.043	.968	175500	-108100	52826
1954-55	6402.81	6405.08	-2.27	3686600	53010	0.74	26200	0.68	74500	30100	0.98	1.044	.967	175800	-119400	54484
1955-56	6401.80	6404.67	-2.87	3665000	52500	1.50	52500	1.31	96900	103300	1.00	1.046	.966	177500	-21600	54701
1956-57	6400.76	6403.54	-2.78	3605900	52380	0.88	30700	0.92	49300	90700	1.02	1.046	.966	180600	-59100	55597
1957-58	6401.21	6404.24	-3.03	3642500	52110	1.35	46900	1.15	20400	153400	0.93	1.047	.965	163700	36600	54986
1958-59	6399.43	6401.81	-2.38	3516100	52270	0.80	27900	0.69	80400	25900	1.02	1.046	.966	180300	-126400	57017
1959-60	6397.25	6398.88	-1.63	3365800	51750	0.37	12800	0.56	69800	16600	1.03	1.048	.964	179800	-150300	59450
1960-61	6395.19	6396.98	-1.79	3269400	50850	0.85	28800	0.55	66100	18700	0.84	1.050	.963	144000	-96400	61086
1961-62	6393.63	6395.59	-1.96	3199700	50420	1.22	41000	0.98	91500	58800	1.00	1.052	.961	169600	-69700	62298
1962-63	6392.39	6394.66	-2.27	3153400	50040	1.35	45100	1.07	86900	76800	1.00	1.053	.961	168300	-46300	63153
1963-64	6390.17	6392.07	-1.90	3025500	49710	0.76	25200	0.60	86200	18800	1.03	1.054	.960	172000	-127900	65760
1964-65	6388.69	6390.67	-1.98	2957300	48990	1.09	35600	1.13	96300	76800	1.10	1.056	.958	180700	-68200	67149
1965-66	6387.05	6388.45	-1.40	2850700	48560	0.95	30800	0.84	80800	48100	1.14	1.057	.958	185600	-106600	69594
1966-67	6388.35	6390.23	-1.88	2936300	47720	1.49	47400	1.42	21400	193100	0.97	1.059	.956	154900	85600	67438
1967-68	6386.79	6387.73	-0.94	2816500	48380	0.46	14800	0.77	73000	45200	1.11	1.058	.957	179900	-119800	70373
1968-69	6389.12	6390.67	-1.55	2957300	47530	1.49	47200	1.63	5900	239800	0.92	1.060	.955	146200	140000	66896
1969-70	6387.65	6388.70	-1.05	2862600	48560	0.75	24300	0.76	87200	60000	1.10	1.057	.958	179100	-94700	69305
1970-71	6385.77	6386.81	-1.04	2772800	47790	0.76	24200	0.89	94300	42600	0.98	1.059	.956	156700	-89800	71414
1971-72	6383.92	6383.99	-0.07	2641300	47270	0.87	27400	0.74	104500	10100	1.07	1.061	.955	169100	-131500	74828
1972-73	6382.41	6382.79	-0.38	2586800	45660	1.05	32000	1.05	101700	59500	0.96	1.064	.952	146100	-54500	76109
1973-74	6380.67	6381.52	-0.85	2529800	45280	1.14	34400	1.15	123600	53300	0.96	1.065	.952	144800	-57000	77033
1974-75	6379.00	6379.83	-0.83	2454600	44860	1.16	34700	1.00	122600	31700	0.95	1.067	.950	141700	-75200	80967
1975-76	6377.37	6377.51	-0.14	2355700	43780	0.73	21300	0.55	76000	9100	0.87	1.069	.949	129400	-98900	83272
1976-77	6375.23	6375.00	0.22	2251200	42160	0.59	16600	0.44	45000	22600	1.03	1.072	.946	143800	-104500	86694
1977-78	6374.61	6375.43	-0.82	2268800	40510	1.72	46500	1.24	98100	91600	0.90	1.075	.944	120500	17600	85979
1978-79	6373.07	6372.29	0.77	2146800	40930	1.08	29500	1.03	140500	18800	1.26	1.075	.944	170400	-127000	90865
1979-80	6373.50	6372.68	0.81	2161300	36920	1.40	34500	1.37	89200	119800	1.15	1.079	.941	139800	14500	89721
1980-81	6371.94	6369.38	2.55	2042000	37490	0.72	18000	0.80	109200	14600	1.23	1.078	.942	152000	-119300	95263
1981-82	6372.41	6370.47	1.93	2081000	35330	1.80	42400	1.48	103000	123000	1.09	1.083	.938	126400	39000	93046
1982-83	6378.22	6375.63	2.58	2277100	35870	1.47	35200	1.93	0	290700	1.10	1.081	.940	129800	196100	85190
1983-84	6379.73	6376.92	2.80	2330700	41130	0.99	27200	1.35	45000	159700	0.98	1.074	.945	133300	53600	83774
1984-85	6378.34	6376.84	1.49	2327300	41920	0.66	18500	0.84	0	126500	1.07	1.073	.946	148500	-3400	83574

* DENOTES BREAK IN PRINTOUT OF YEARS WHERE CHANGE IN ELEV<=.05'

****END OF MONO LAKE MODEL****

MONO LAKE HYDROLOGIC MODEL (Hypothetical Export of 0 AF/Yr)

MONO LAKE MODEL

LOS ANGELES DEPARTMENT OF WATER AND POWER
AQUEDUCT DIVISION - GROUNDWATER SECTION

RUNDATE: 03-01-1987
TIME: 21:18:22

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
								SURFACE & SUBSURFACE			**** LAKE EVAPORATION *****					
WATER YEAR	MEASURED ELEV (ft)	CALC ELEV (ft)	MODEL DIFF (ft)	CALC VOLUME (acft)	CALC SURFACE AREA (acres)	LAKE INDX	PRECIP ANNUAL (acft)	INDX	W.PORT EXPORT (acft)	INFLOW (acft)	INDX	LAKE S.G.	EVAP ADJ.	ANNUAL (acft)	CHANGE IN STORAGE (acft)	TDS IN PPM
1986		6380.2		2470700	44130											
1986-87		6381.14		2512500	44130	1.00	29400	1.00	0	150600	1.00	1.068	.949	138200	41800	78149
1987-88		6382.03		2552700	44720	1.00	29800	1.00	0	150600	1.00	1.067	.950	140200	40200	76990
1988-89		6382.90		2592000	45040	1.00	30000	1.00	0	150600	1.00	1.066	.951	141300	39300	75094
1989-90		6383.75		2630400	45320	1.00	30200	1.00	0	150600	1.00	1.065	.952	142400	38400	74856
1990-91		6384.57		2668200	45590	1.00	30400	1.00	0	150600	1.00	1.064	.952	143200	37800	73865
1991-92		6385.36		2704600	46110	1.00	30800	1.00	0	150600	1.00	1.063	.953	145000	36400	72939
1992-93		6386.11		2739600	46650	1.00	31100	1.00	0	150600	1.00	1.063	.953	146700	35000	72008
1993-94		6386.83		2773500	47050	1.00	31400	1.00	0	150600	1.00	1.062	.954	148100	33900	71194
1994-95		6387.52		2806600	47280	1.00	31500	1.00	0	150600	1.00	1.061	.955	149000	33100	70421
1995-96		6388.21		2839300	47470	1.00	31700	1.00	0	150600	1.00	1.060	.955	149600	32700	69676
1996-97		6388.89		2871500	47660	1.00	31800	1.00	0	150600	1.00	1.060	.955	150200	32200	68894
1997-98		6389.55		2903100	47840	1.00	31900	1.00	0	150600	1.00	1.059	.956	150900	31600	68209
1998-99		6390.19		2933900	48100	1.00	32100	1.00	0	150600	1.00	1.058	.957	151900	30800	67557
1999- 0		6390.81		2964000	48370	1.00	32300	1.00	0	150600	1.00	1.058	.957	152800	30100	66871
2000- 1		6391.41		2993300	48610	1.00	32400	1.00	0	150600	1.00	1.057	.958	153700	29300	66279
2001- 2		6392.00		3022100	48800	1.00	32500	1.00	0	150600	1.00	1.057	.958	154300	28800	65647
2002- 3		6392.58		3050600	48970	1.00	32700	1.00	0	150600	1.00	1.056	.958	154800	28500	65095
2003- 4		6393.14		3078500	49120	1.00	32800	1.00	0	150600	1.00	1.055	.959	155500	27900	64566
2004- 5		6393.70		3106100	49260	1.00	32900	1.00	0	150600	1.00	1.055	.959	155900	27600	63993
2005- 6		6394.25		3133100	49390	1.00	32900	1.00	0	150600	1.00	1.054	.960	156500	27000	63501
2006- 7		6394.79		3159800	49560	1.00	33100	1.00	0	150600	1.00	1.054	.960	157000	26700	62965
2007- 8		6395.31		3186000	49760	1.00	33200	1.00	0	150600	1.00	1.054	.960	157600	26200	62447
2008- 9		6395.82		3211500	49940	1.00	33300	1.00	0	150600	1.00	1.053	.961	158400	25500	62010
2009-10		6396.32		3236600	50110	1.00	33400	1.00	0	150600	1.00	1.053	.961	158900	25100	61529
2010-11		6396.81		3261300	50250	1.00	33500	1.00	0	150600	1.00	1.052	.961	159400	24700	61121
2011-12		6397.30		3285800	50370	1.00	33600	1.00	0	150600	1.00	1.052	.961	159700	24500	60665
2012-13		6397.78		3310000	50490	1.00	33700	1.00	0	150600	1.00	1.052	.961	160100	24200	60222
2013-14		6398.25		3333800	50600	1.00	33800	1.00	0	150600	1.00	1.051	.962	160600	23800	59849
2014-15		6398.71		3357200	50700	1.00	33800	1.00	0	150600	1.00	1.051	.962	161000	23400	59432
2015-16		6399.16		3380200	50810	1.00	33900	1.00	0	150600	1.00	1.050	.963	161500	23000	59084
2016-17		6399.61		3402900	50930	1.00	34000	1.00	0	150600	1.00	1.050	.963	161900	22700	58689
2017-18		6400.05		3425300	51080	1.00	34100	1.00	0	150600	1.00	1.050	.963	162300	22400	58306
2018-19		6400.47		3447100	51240	1.00	34200	1.00	0	150600	1.00	1.049	.964	163000	21800	57992
2019-20		6400.89		3468500	51380	1.00	34300	1.00	0	150600	1.00	1.049	.964	163500	21400	57634
2020-21		6401.29		3489600	51530	1.00	34400	1.00	0	150600	1.00	1.049	.964	163900	21100	57286
2021-22		6401.70		3510300	51640	1.00	34400	1.00	0	150600	1.00	1.048	.964	164300	20700	57002
2022-23		6402.09		3530800	51730	1.00	34500	1.00	0	150600	1.00	1.048	.964	164600	20500	56671
2023-24		6402.48		3551200	51810	1.00	34600	1.00	0	150600	1.00	1.048	.964	164800	20400	56346
2024-25		6402.87		3571300	51890	1.00	34600	1.00	0	150600	1.00	1.048	.964	165100	20100	56029
2025-26		6403.25		3591100	51970	1.00	34700	1.00	0	150600	1.00	1.047	.965	165500	19800	55773
2026-27		6403.63		3610600	52050	1.00	34700	1.00	0	150600	1.00	1.047	.965	165800	19500	55472

MONO LAKE HYDROLOGIC MODEL (Hypothetical Export of 0 AF/Yr)

2027-28	6404.00	3630000	52130	1.00	34800	1.00	0	150600	1.00	1.047	.965	166000	19400	55175
2028-29	6404.37	3649200	52200	1.00	34800	1.00	0	150600	1.00	1.047	.965	166200	19200	54885
2029-30	6404.73	3668000	52300	1.00	34900	1.00	0	150600	1.00	1.046	.966	166700	18800	54656
2030-31	6405.08	3686600	52400	1.00	35000	1.00	0	150600	1.00	1.046	.966	167000	18600	54380
2031-32	6405.43	3704800	52500	1.00	35000	1.00	0	150600	1.00	1.046	.966	167400	18200	54113
2032-33	6405.77	3722800	52600	1.00	35100	1.00	0	150600	1.00	1.046	.966	167700	18000	53851
2033-34	6406.10	3740400	52690	1.00	35100	1.00	0	150600	1.00	1.045	.967	168100	17600	53649
2034-35	6406.43	3757800	52780	1.00	35200	1.00	0	150600	1.00	1.045	.967	168400	17400	53401
2035-36	6406.76	3775000	52840	1.00	35200	1.00	0	150600	1.00	1.045	.967	168600	17200	53158
2036-37	6407.08	3792100	52900	1.00	35300	1.00	0	150600	1.00	1.045	.967	168800	17100	52918
2037-38	6407.40	3809000	52960	1.00	35300	1.00	0	150600	1.00	1.045	.967	169000	16900	52683
2038-39	6407.72	3825800	53020	1.00	35400	1.00	0	150600	1.00	1.044	.967	169200	16800	52502
2039-40	6408.03	3842400	53080	1.00	35400	1.00	0	150600	1.00	1.044	.967	169400	16600	52275
2040-41	6408.34	3858800	53140	1.00	35400	1.00	0	150600	1.00	1.044	.967	169600	16400	52053
2041-42	6408.64	3875200	53190	1.00	35500	1.00	0	150600	1.00	1.044	.967	169700	16400	51833
2042-43	6408.95	3891400	53240	1.00	35500	1.00	0	150600	1.00	1.044	.967	169900	16200	51617
2043-44	6409.25	3907300	53290	1.00	35500	1.00	0	150600	1.00	1.043	.968	170200	15900	51456
2044-45	6409.54	3923000	53360	1.00	35600	1.00	0	150600	1.00	1.043	.968	170500	15700	51250
2045-46	6409.83	3938500	53430	1.00	35600	1.00	0	150600	1.00	1.043	.968	170700	15500	51049
2046-47	6410.12	3953900	53500	1.00	35700	1.00	0	150600	1.00	1.043	.968	170900	15400	50850
2047-48	6410.40	3969100	53570	1.00	35700	1.00	0	150600	1.00	1.043	.968	171100	15200	50655
2048-49	6410.68	3984200	53640	1.00	35800	1.00	0	150600	1.00	1.043	.968	171300	15100	50463
2049-50	6410.96	3998800	53720	1.00	35800	1.00	0	150600	1.00	1.042	.969	171800	14600	50327
2050-51	6411.22	4013300	53790	1.00	35900	1.00	0	150600	1.00	1.042	.969	172000	14500	50145
2051-52	6411.49	4027600	53840	1.00	35900	1.00	0	150600	1.00	1.042	.969	172200	14300	49967
2052-53	6411.75	4041800	53890	1.00	35900	1.00	0	150600	1.00	1.042	.969	172300	14200	49792
2053-54	6412.01	4055900	53930	1.00	36000	1.00	0	150600	1.00	1.042	.969	172500	14100	49618
2054-55	6412.27	4069900	53970	1.00	36000	1.00	0	150600	1.00	1.042	.969	172600	14000	49440
2055-56	6412.53	4083800	54020	1.00	36000	1.00	0	150600	1.00	1.042	.969	172700	13900	49279
2056-57	6412.79	4097600	54060	1.00	36100	1.00	0	150600	1.00	1.041	.969	172900	13800	49161
2057-58	6413.04	4111300	54110	1.00	36100	1.00	0	150600	1.00	1.041	.969	173000	13700	48997
2058-59	6413.29	4124800	54150	1.00	36100	1.00	0	150600	1.00	1.041	.969	173200	13500	48837
2059-60	6413.54	4138200	54190	1.00	36100	1.00	0	150600	1.00	1.041	.969	173300	13400	48678
2060-61	6413.78	4151600	54220	1.00	36200	1.00	0	150600	1.00	1.041	.969	173400	13400	48521
2061-62	6414.03	4164900	54260	1.00	36200	1.00	0	150600	1.00	1.041	.969	173500	13300	48366
2062-63	6414.27	4178100	54300	1.00	36200	1.00	0	150600	1.00	1.041	.969	173600	13200	48214
2063-64	6414.51	4191200	54350	1.00	36300	1.00	0	150600	1.00	1.041	.969	173800	13100	48063
2064-65	6414.75	4204000	54400	1.00	36300	1.00	0	150600	1.00	1.040	.970	174100	12800	47963
2065-66	6414.98	4216600	54450	1.00	36300	1.00	0	150600	1.00	1.040	.970	174300	12600	47819
2066-67	6415.21	4229100	54500	1.00	36400	1.00	0	150600	1.00	1.040	.970	174500	12500	47678
2067-68	6415.43	4241500	54550	1.00	36400	1.00	0	150600	1.00	1.040	.970	174600	12400	47539
2068-69	6415.66	4253700	54610	1.00	36400	1.00	0	150600	1.00	1.040	.970	174800	12200	47402
2069-70	6415.88	4265800	54670	1.00	36500	1.00	0	150600	1.00	1.040	.970	175000	12100	47268
2070-71	6416.10	4277700	54730	1.00	36500	1.00	0	150600	1.00	1.040	.970	175200	11900	47136
2071-72	6416.31	4289500	54770	1.00	36500	1.00	0	150600	1.00	1.040	.970	175300	11800	47007
2072-73	6416.52	4301100	54810	1.00	36600	1.00	0	150600	1.00	1.039	.971	175600	11600	46925
2073-74	6416.73	4312600	54840	1.00	36600	1.00	0	150600	1.00	1.039	.971	175700	11500	46800
2074-75	6416.94	4323900	54880	1.00	36600	1.00	0	150600	1.00	1.039	.971	175900	11300	46677
2075-76	6417.14	4335100	54920	1.00	36600	1.00	0	150600	1.00	1.039	.971	176000	11200	46557
2076-77	6417.35	4346300	54950	1.00	36700	1.00	0	150600	1.00	1.039	.971	176100	11200	46437
2077-78	6417.55	4357400	54990	1.00	36700	1.00	0	150600	1.00	1.039	.971	176200	11100	46319

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2078-79	6417.75	4368400	55020	1.00	36700	1.00	0	150600	1.00	1.039	.971	176300	11000	46202
2079-80	6417.95	4379300	55060	1.00	36700	1.00	0	150600	1.00	1.039	.971	176400	10900	46087
2080-81	6418.14	4390100	55090	1.00	36700	1.00	0	150600	1.00	1.039	.971	176500	10800	45974
2081-82	6418.34	4400900	55120	1.00	36800	1.00	0	150600	1.00	1.039	.971	176600	10800	45861
2082-83	6418.53	4411400	55150	1.00	36800	1.00	0	150600	1.00	1.038	.972	176900	10500	45796
2083-84	6418.72	4421800	55180	1.00	36800	1.00	0	150600	1.00	1.038	.972	177000	10400	45688
2084-85	6418.90	4432100	55210	1.00	36800	1.00	0	150600	1.00	1.038	.972	177100	10300	45582
2085-86	6419.09	4442300	55240	1.00	36800	1.00	0	150600	1.00	1.038	.972	177200	10300	45477
2086-87	6419.27	4452500	55280	1.00	36900	1.00	0	150600	1.00	1.038	.972	177300	10200	45373
2087-88	6419.46	4462600	55320	1.00	36900	1.00	0	150600	1.00	1.038	.972	177400	10100	45270
2088-89	6419.63	4472500	55370	1.00	36900	1.00	0	150600	1.00	1.038	.972	177600	9900	45170
2089-90	6419.81	4482400	55410	1.00	37000	1.00	0	150600	1.00	1.038	.972	177700	9800	45070
2090-91	6419.99	4492100	55460	1.00	37000	1.00	0	150600	1.00	1.038	.972	177900	9700	44973
2091-92	6420.16	4501700	55500	1.00	37000	1.00	0	150600	1.00	1.038	.972	178000	9600	44877
2092-93	6420.33	4511200	55550	1.00	37100	1.00	0	150600	1.00	1.038	.972	178200	9500	44783
2093-94	6420.50	4520600	55590	1.00	37100	1.00	0	150600	1.00	1.038	.972	178300	9400	44689
2094-95	6420.67	4529800	55640	1.00	37100	1.00	0	150600	1.00	1.037	.972	178500	9200	44642
2095-96	6420.83	4538900	55680	1.00	37100	1.00	0	150600	1.00	1.037	.972	178600	9100	44552
2096-97	6420.99	4548000	55720	1.00	37200	1.00	0	150600	1.00	1.037	.972	178700	9100	44463
2097-98	6421.15	4556900	55770	1.00	37200	1.00	0	150600	1.00	1.037	.972	178900	8900	44376
2098-99	6421.31	4565700	55790	1.00	37200	1.00	0	150600	1.00	1.037	.972	179000	8800	44291
2099- 0	6421.47	4574500	55820	1.00	37200	1.00	0	150600	1.00	1.037	.972	179000	8800	44205
2100- 1	6421.62	4583300	55850	1.00	37300	1.00	0	150600	1.00	1.037	.972	179100	8800	44121
2101- 2	6421.78	4592000	55870	1.00	37300	1.00	0	150600	1.00	1.037	.972	179200	8700	44037
2102- 3	6421.93	4600600	55900	1.00	37300	1.00	0	150600	1.00	1.037	.972	179300	8600	43955
2103- 4	6422.09	4609100	55920	1.00	37300	1.00	0	150600	1.00	1.037	.972	179400	8500	43874
2104- 5	6422.24	4617500	55950	1.00	37300	1.00	0	150600	1.00	1.037	.972	179500	8400	43794
2105- 6	6422.39	4625900	55970	1.00	37300	1.00	0	150600	1.00	1.037	.972	179500	8400	43714
2106- 7	6422.54	4634300	56000	1.00	37400	1.00	0	150600	1.00	1.037	.972	179600	8400	43635
2107- 8	6422.68	4642600	56020	1.00	37400	1.00	0	150600	1.00	1.037	.972	179700	8300	43557
2108- 9	6422.83	4650600	56050	1.00	37400	1.00	0	150600	1.00	1.036	.973	180000	8000	43524
2109-10	6422.97	4658600	56070	1.00	37400	1.00	0	150600	1.00	1.036	.973	180000	8000	43449
2110-11	6423.11	4666500	56100	1.00	37400	1.00	0	150600	1.00	1.036	.973	180100	7900	43376
2111-12	6423.25	4674300	56120	1.00	37400	1.00	0	150600	1.00	1.036	.973	180200	7800	43303
2112-13	6423.39	4682100	56150	1.00	37500	1.00	0	150600	1.00	1.036	.973	180300	7800	43231
2113-14	6423.53	4689800	56180	1.00	37500	1.00	0	150600	1.00	1.036	.973	180400	7700	43160
2114-15	6423.66	4697400	56200	1.00	37500	1.00	0	150600	1.00	1.036	.973	180500	7600	43090
2115-16	6423.80	4705000	56230	1.00	37500	1.00	0	150600	1.00	1.036	.973	180500	7600	43021
2116-17	6423.93	4712500	56260	1.00	37500	1.00	0	150600	1.00	1.036	.973	180600	7500	42952
2117-18	6424.06	4719900	56280	1.00	37500	1.00	0	150600	1.00	1.036	.973	180700	7400	42885
2118-19	6424.19	4727300	56310	1.00	37600	1.00	0	150600	1.00	1.036	.973	180800	7400	42818
2119-20	6424.32	4734500	56360	1.00	37600	1.00	0	150600	1.00	1.036	.973	181000	7200	42753
2120-21	6424.45	4741600	56400	1.00	37600	1.00	0	150600	1.00	1.036	.973	181100	7100	42689
2121-22	6424.57	4748600	56450	1.00	37700	1.00	0	150600	1.00	1.036	.973	181300	7000	42626
2122-23	6424.69	4755500	56490	1.00	37700	1.00	0	150600	1.00	1.036	.973	181400	6900	42564
2123-24	6424.81	4762300	56530	1.00	37700	1.00	0	150600	1.00	1.036	.973	181500	6800	42503
2124-25	6424.93	4769000	56570	1.00	37700	1.00	0	150600	1.00	1.036	.973	181600	6700	42444
2125-26	6425.04	4775400	56610	1.00	37800	1.00	0	150600	1.00	1.035	.974	182000	6400	42428
2126-27	6425.15	4781700	56640	1.00	37800	1.00	0	150600	1.00	1.035	.974	182100	6300	42372
2127-28	6425.27	4788000	56670	1.00	37800	1.00	0	150600	1.00	1.035	.974	182100	6300	42316
2128-29	6425.37	4794100	56710	1.00	37800	1.00	0	150600	1.00	1.035	.974	182300	6100	42262
2129-30	6425.48	4800100	56740	1.00	37800	1.00	0	150600	1.00	1.035	.974	182400	6000	42209
2130-31	6425.58	4806100	56770	1.00	37900	1.00	0	150600	1.00	1.035	.974	182500	6000	42157

MONO LAKE HYDROLOGIC MODEL (Hypothetical Export of 0 AF/Yr)

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2131-32   6425.69   4812000  56800  1.00  37900  1.00    0  150600  1.00  1.035  .974  182600   5900  42105
2132-33   6425.79   4817800  56830  1.00  37900  1.00    0  150600  1.00  1.035  .974  182700   5800  42054
2133-34   6425.89   4823500  56860  1.00  37900  1.00    0  150600  1.00  1.035  .974  182800   5700  42004
2134-35   6425.99   4829100  56890  1.00  37900  1.00    0  150600  1.00  1.035  .974  182900   5600  41956
2135-36   6426.09   4834700  56920  1.00  38000  1.00    0  150600  1.00  1.035  .974  183000   5600  41907
2136-37   6426.19   4840300  56940  1.00  38000  1.00    0  150600  1.00  1.035  .974  183000   5600  41859
2137-38   6426.28   4845800  56960  1.00  38000  1.00    0  150600  1.00  1.035  .974  183100   5500  41811
2138-39   6426.38   4851300  56980  1.00  38000  1.00    0  150600  1.00  1.035  .974  183100   5500  41764
2139-40   6426.47   4856700  57000  1.00  38000  1.00    0  150600  1.00  1.035  .974  183200   5400  41717
2140-41   6426.57   4862000  57020  1.00  38000  1.00    0  150600  1.00  1.035  .974  183300   5300  41672
2141-42   6426.66   4867300  57050  1.00  38100  1.00    0  150600  1.00  1.035  .974  183400   5300  41627
2142-43   6426.75   4872600  57070  1.00  38100  1.00    0  150600  1.00  1.035  .974  183400   5300  41581
2143-44   6426.84   4877800  57090  1.00  38100  1.00    0  150600  1.00  1.035  .974  183500   5200  41537
2144-45   6426.93   4882900  57110  1.00  38100  1.00    0  150600  1.00  1.035  .974  183600   5100  41494
2145-46   6427.02   4888000  57130  1.00  38100  1.00    0  150600  1.00  1.035  .974  183600   5100  41450
2146-47   6427.11   4893000  57150  1.00  38100  1.00    0  150600  1.00  1.035  .974  183700   5000  41408
2147-48   6427.19   4897900  57180  1.00  38100  1.00    0  150600  1.00  1.035  .974  183800   4900  41366
2148-49   6427.28   4902800  57200  1.00  38200  1.00    0  150600  1.00  1.035  .974  183900   4900  41325
2149-50   6427.37   4907700  57220  1.00  38200  1.00    0  150600  1.00  1.035  .974  183900   4900  41284
2150-51   6427.45   4912300  57250  1.00  38200  1.00    0  150600  1.00  1.034  .975  184200   4600  41285
2151-52   6427.52   4916800  57270  1.00  38200  1.00    0  150600  1.00  1.034  .975  184300   4500  41247
2152-53   6427.60   4921300  57290  1.00  38200  1.00    0  150600  1.00  1.034  .975  184300   4500  41210
2153-54   6427.68   4925700  57310  1.00  38200  1.00    0  150600  1.00  1.034  .975  184400   4400  41173
2154-55   6427.76   4930000  57330  1.00  38200  1.00    0  150600  1.00  1.034  .975  184500   4300  41137
2155-56   6427.83   4934300  57360  1.00  38300  1.00    0  150600  1.00  1.034  .975  184600   4300  41101
2156-57   6427.91   4938600  57370  1.00  38300  1.00    0  150600  1.00  1.034  .975  184600   4300  41065
2157-58   6427.98   4942800  57400  1.00  38300  1.00    0  150600  1.00  1.034  .975  184700   4200  41030
2158-59   6428.05   4947000  57420  1.00  38300  1.00    0  150600  1.00  1.034  .975  184700   4200  40995
2159-60   6428.12   4951100  57440  1.00  38300  1.00    0  150600  1.00  1.034  .975  184800   4100  40962
2160-61   6428.19   4955100  57460  1.00  38300  1.00    0  150600  1.00  1.034  .975  184900   4000  40928
2161-62   6428.26   4959000  57490  1.00  38300  1.00    0  150600  1.00  1.034  .975  185000   3900  40896
2162-63   6428.33   4963000  57510  1.00  38400  1.00    0  150600  1.00  1.034  .975  185000   4000  40863
2163-64   6428.40   4966900  57540  1.00  38400  1.00    0  150600  1.00  1.034  .975  185100   3900  40831
2164-65   6428.46   4970700  57560  1.00  38400  1.00    0  150600  1.00  1.034  .975  185200   3800  40800
2165-66   6428.53   4974400  57580  1.00  38400  1.00    0  150600  1.00  1.034  .975  185300   3700  40770
2166-67   6428.59   4978000  57610  1.00  38400  1.00    0  150600  1.00  1.034  .975  185400   3600  40740
2167-68   6428.65   4981600  57630  1.00  38400  1.00    0  150600  1.00  1.034  .975  185400   3600  40711
2168-69   6428.72   4985200  57650  1.00  38500  1.00    0  150600  1.00  1.034  .975  185500   3600  40681
2169-70   6428.78   4988700  57670  1.00  38500  1.00    0  150600  1.00  1.034  .975  185600   3500  40653
2170-71   6428.84   4992200  57690  1.00  38500  1.00    0  150600  1.00  1.034  .975  185600   3500  40624
2171-72   6428.90   4995600  57720  1.00  38500  1.00    0  150600  1.00  1.034  .975  185700   3400  40597
2172-73   6428.95   4998900  57740  1.00  38500  1.00    0  150600  1.00  1.034  .975  185800   3300  40570
2173-74   6429.01   5002200  57750  1.00  38500  1.00    0  150600  1.00  1.034  .975  185800   3300  40543
2174-75   6429.07   5005400  57780  1.00  38500  1.00    0  150600  1.00  1.034  .975  185900   3200  40517
2175-76   6429.12   5008500  57830  1.00  38600  1.00    0  150600  1.00  1.034  .975  186100   3100  40492
2177-78*  6429.22   5014300  57920  1.00  38600  1.00    0  150600  1.00  1.034  .975  186400   2800  40445

2202- 3 /YR THE HISTORICAL CAPACITY OF THE LAKE WAS EXCEEDED
* DENOTES BREAK IN PRINTOUT OF YEARS WHERE CHANGE IN ELEV<=.05'

   ****END OF MONO LAKE MODEL****
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MONO LAKE HYDROLOGIC MODEL (Hypothetical Export of 100,000 AF/Yr.)

MONO LAKE MODEL

LOS ANGELES DEPARTMENT OF WATER AND POWER
AQUEDUCT DIVISION - GROUNDWATER SECTION

RUNDATE: 03-01-1987
TIME: 21:10:33

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
								SURFACE & SUBSURFACE			**** LAKE EVAPORATION *****					
WATER YEAR	MEASURED ELEV (ft)	CALC ELEV (ft)	MODEL DIFF (ft)	CALC VOLUME (acft)	CALC SURFACE AREA (acres)	LAKE INDX	PRECIP ANNUAL (acft)	INDX	W.PORT EXPORT (acft)	INFLOW (acft)	INDX	LAKE S.G.	EVAP ADJ.	ANNUAL (acft)	CHANGE IN STORAGE (acft)	TDS IN PPM
1986		6380.2		2470700	44130											
1986-87		6378.92		2415600	44130	1.00	29400	1.00	100000	53600	1.00	1.068	.949	138200	-55100	81283
1987-88		6377.71		2364200	42720	1.00	28500	1.00	100000	53600	1.00	1.070	.948	133600	-51400	82895
1988-89		6376.52		2314200	42240	1.00	28200	1.00	100000	53600	1.00	1.072	.946	131900	-50000	84528
1989-90		6375.34		2265400	41730	1.00	27800	1.00	100000	53600	1.00	1.073	.946	130300	-48800	86269
1990-91		6374.19		2219100	40840	1.00	27200	1.00	100000	53600	1.00	1.075	.944	127200	-46300	87905
1991-92		6373.09		2176600	39370	1.00	26300	1.00	100000	53600	1.00	1.076	.943	122500	-42500	89538
1992-93		6372.03		2137400	38060	1.00	25400	1.00	100000	53600	1.00	1.078	.942	118300	-39200	91011
1993-94		6371.06		2102100	36530	1.00	24400	1.00	100000	53600	1.00	1.079	.941	113400	-35300	92454
1994-95		6370.11		2067900	36110	1.00	24100	1.00	100000	53600	1.00	1.081	.940	112000	-34200	93809
1995-96		6369.17		2034700	35720	1.00	23800	1.00	100000	53600	1.00	1.082	.939	110700	-33200	95251
1996-97		6368.26		2002900	35210	1.00	23500	1.00	100000	53600	1.00	1.083	.938	109000	-31800	96674
1997-98		6367.37		1972200	34750	1.00	23200	1.00	100000	53600	1.00	1.084	.938	107600	-30700	98089
1998-99		6366.51		1942600	34390	1.00	22900	1.00	100000	53600	1.00	1.086	.936	106200	-29600	99400
1999- 0		6365.66		1913800	34120	1.00	22800	1.00	100000	53600	1.00	1.087	.935	105300	-28800	100803
2000- 1		6364.83		1885600	33870	1.00	22600	1.00	100000	53600	1.00	1.088	.935	104500	-28200	102216
2001- 2		6364.01		1858200	33620	1.00	22400	1.00	100000	53600	1.00	1.090	.933	103500	-27400	103533
2002- 3		6363.21		1831600	33370	1.00	22300	1.00	100000	53600	1.00	1.091	.932	102600	-26600	104940
2003- 4		6362.42		1805500	33120	1.00	22100	1.00	100000	53600	1.00	1.092	.932	101900	-26100	106360
2004- 5		6361.64		1780200	32890	1.00	21900	1.00	100000	53600	1.00	1.094	.930	100900	-25300	107674
2005- 6		6360.89		1755600	32650	1.00	21800	1.00	100000	53600	1.00	1.095	.929	100100	-24600	109083
2006- 7		6360.14		1731500	32420	1.00	21600	1.00	100000	53600	1.00	1.096	.929	99400	-24100	110501
2007- 8		6359.42		1708200	32190	1.00	21500	1.00	100000	53600	1.00	1.098	.927	98500	23300	111804
2008- 9		6358.70		1685500	31970	1.00	21300	1.00	100000	53600	1.00	1.099	.926	97700	-22700	113207
2009-10		6358.01		1663400	31750	1.00	21200	1.00	100000	53600	1.00	1.100	.926	97000	-22100	114606
2010-11		6357.32		1641900	31550	1.00	21000	1.00	100000	53600	1.00	1.102	.924	96200	-21500	115896
2011-12		6356.65		1621000	31370	1.00	20900	1.00	100000	53600	1.00	1.103	.923	95500	-20000	117284
2012-13		6356.00		1600500	31200	1.00	20800	1.00	100000	53600	1.00	1.104	.923	95000	-20500	118679
2013-14		6355.35		1580600	31040	1.00	20700	1.00	100000	53600	1.00	1.106	.921	94300	-19900	119956
2014-15		6354.72		1561100	30880	1.00	20600	1.00	100000	53600	1.00	1.107	.920	93800	-19500	121344
2015-16		6354.10		1542000	30740	1.00	20500	1.00	100000	53600	1.00	1.108	.920	93300	-19100	122737
2016-17		6353.49		1523400	30590	1.00	20400	1.00	100000	53600	1.00	1.110	.918	92700	-18600	124011
2017-18		6352.89		1505300	30450	1.00	20300	1.00	100000	53600	1.00	1.111	.917	92100	-18100	125390
2018-19		6352.30		1487500	30310	1.00	20200	1.00	100000	53600	1.00	1.112	.917	91700	-17800	126776
2019-20		6351.73		1470200	30160	1.00	20100	1.00	100000	53600	1.00	1.114	.915	91100	-17300	128037
2020-21		6351.17		1453400	30020	1.00	20000	1.00	100000	53600	1.00	1.115	.914	90500	-16800	129401
2021-22		6350.61		1436900	29880	1.00	19900	1.00	100000	53600	1.00	1.116	.914	90100	-16500	130770
2022-23		6350.07		1420900	29740	1.00	19800	1.00	100000	53600	1.00	1.118	.912	89500	-16000	132006
2023-24		6349.55		1405300	29600	1.00	19700	1.00	100000	53600	1.00	1.119	.911	89000	-15600	133352
2024-25		6349.03		1390100	29470	1.00	19700	1.00	100000	53600	1.00	1.120	.911	88600	-15200	134690
2025-26		6348.53		1375400	29330	1.00	19600	1.00	100000	53600	1.00	1.122	.909	88000	-14700	135887
2026-27		6348.04		1361100	29210	1.00	19500	1.00	100000	53600	1.00	1.123	.908	87500	-14300	137192
2027-28		6347.56		1347200	29080	1.00	19400	1.00	100000	53600	1.00	1.124	.907	87000	-13900	138484
2028-29		6347.09		1333700	28950	1.00	19300	1.00	100000	53600	1.00	1.126	.905	86500	-13500	139637
2029-30		6346.63		1320600	28820	1.00	19200	1.00	100000	53600	1.00	1.127	.904	86000	-13100	140897
2030-31		6346.19		1307900	28680	1.00	19100	1.00	100000	53600	1.00	1.128	.903	85500	-12700	142140
2031-32		6345.76		1295600	28560	1.00	19000	1.00	100000	53600	1.00	1.129	.902	85000	-12300	143362
2032-33		6345.34		1283800	28440	1.00	19000	1.00	100000	53600	1.00	1.131	.900	84500	-11800	144424
2033-34		6344.94		1272400	28320	1.00	18900	1.00	100000	53600	1.00	1.132	.899	84000	-11400	145589
2034-35		6344.54		1261300	28200	1.00	18800	1.00	100000	53600	1.00	1.133	.898	83600	-11100	146741
2035-36		6344.16		1250600	28090	1.00	18700	1.00	100000	53600	1.00	1.134	.897	83100	-10700	147866

MODEL MONO LAKE HYDROLOGIC MODEL (Hypothetical Export of 100,000 AF/Yr)

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2036-37     6343.79     1240300  27970  1.00  18700  1.00  100000  53600  1.00  1.135  .896  82700  -10300  148962
2037-38     6343.43     1230300  27860  1.00  18600  1.00  100000  53600  1.00  1.136  .895  82300  -10000  150041
2038-39     6343.09     1220800  27740  1.00  18500  1.00  100000  53600  1.00  1.138  .893  81700   -9500  150943
2039-40     6342.76     1211600  27630  1.00  18400  1.00  100000  53600  1.00  1.139  .892  81300   -9200  151955
2040-41     6342.44     1202800  27520  1.00  18400  1.00  100000  53600  1.00  1.140  .891  80900   -8800  152933
2041-42     6342.12     1194200  27420  1.00  18300  1.00  100000  53600  1.00  1.141  .891  80600   -8600  153899
2042-43     6341.82     1185900  27320  1.00  18200  1.00  100000  53600  1.00  1.142  .890  80200   -8300  154840
2043-44     6341.52     1177900  27220  1.00  18200  1.00  100000  53600  1.00  1.143  .889  79900   -8000  155756
2044-45     6341.24     1170200  27120  1.00  18100  1.00  100000  53600  1.00  1.144  .888  79500   -7700  156643
2045-46     6340.97     1162800  27030  1.00  18000  1.00  100000  53600  1.00  1.145  .887  79100   -7400  157503
2046-47     6340.70     1155700  26950  1.00  18000  1.00  100000  53600  1.00  1.146  .886  78800   -7100  158332
2047-48     6340.44     1148700  26870  1.00  17900  1.00  100000  53600  1.00  1.146  .886  78600   -7000  159297
2048-49     6340.19     1142000  26800  1.00  17900  1.00  100000  53600  1.00  1.147  .885  78300   -6700  160092
2049-50     6339.95     1135500  26730  1.00  17800  1.00  100000  53600  1.00  1.148  .884  78000   -6500  160868
2050-51     6339.71     1129300  26660  1.00  17800  1.00  100000  53600  1.00  1.149  .883  77700   -6200  161610
2051-52     6339.49     1123300  26590  1.00  17700  1.00  100000  53600  1.00  1.150  .882  77400   -6000  162332
2052-53     6339.27     1117600  26530  1.00  17700  1.00  100000  53600  1.00  1.151  .881  77100   -5700  163018
2053-54     6339.06     1112000  26460  1.00  17600  1.00  100000  53600  1.00  1.151  .881  76900   -5600  163839
2054-55     6338.86     1106600  26400  1.00  17600  1.00  100000  53600  1.00  1.152  .880  76700   -5400  164496
2055-56     6338.66     1101500  26350  1.00  17600  1.00  100000  53600  1.00  1.153  .879  76400   -5100  165114
2056-57     6338.47     1096500  26290  1.00  17500  1.00  100000  53600  1.00  1.154  .878  76200   -5000  165723
2057-58     6338.29     1091700  26240  1.00  17500  1.00  100000  53600  1.00  1.154  .878  76000   -4800  166452
2058-59     6338.11     1087100  26190  1.00  17500  1.00  100000  53600  1.00  1.155  .877  75800   -4600  167012
2059-60     6337.94     1082600  26140  1.00  17400  1.00  100000  53600  1.00  1.156  .876  75600   -4500  167561
2060-61     6337.78     1078300  26090  1.00  17400  1.00  100000  53600  1.00  1.156  .876  75400   -4300  168229
2061-62     6337.62     1074200  26040  1.00  17400  1.00  100000  53600  1.00  1.157  .875  75200   -4100  168725
2062-63     6337.46     1070200  25990  1.00  17300  1.00  100000  53600  1.00  1.158  .874  75000   -4000  169210
2063-64     6337.32     1066400  25950  1.00  17300  1.00  100000  53600  1.00  1.158  .874  74800   -3800  169813
2064-65     6337.18     1062800  25900  1.00  17300  1.00  100000  53600  1.00  1.159  .873  74600   -3600  170411
2065-66     6337.04     1059200  25860  1.00  17200  1.00  100000  53600  1.00  1.159  .873  74500   -3600  170819
2066-67     6336.91     1055800  25820  1.00  17200  1.00  100000  53600  1.00  1.160  .872  74300   -3400  171232
2067-68     6336.78     1052500  25780  1.00  17200  1.00  100000  53600  1.00  1.160  .872  74200   -3300  171759
2068-69     6336.66     1049400  25740  1.00  17200  1.00  100000  53600  1.00  1.161  .871  74000   -3100  172118
2069-70     6336.54     1046300  25710  1.00  17100  1.00  100000  53600  1.00  1.161  .871  73900   -3100  172620
2070-71     6336.43     1043400  25670  1.00  17100  1.00  100000  53600  1.00  1.162  .870  73700   -2900  172958
2071-72     6336.32     1040600  25640  1.00  17100  1.00  100000  53600  1.00  1.162  .870  73600   -2800  173424
2072-73     6336.21     1038000  25610  1.00  17100  1.00  100000  53600  1.00  1.163  .869  73400    2600  173709
2073-74     6336.11     1035400  25580  1.00  17100  1.00  100000  53600  1.00  1.163  .869  73400   -2600  174145
2074-75     6336.01     1032800  25550  1.00  17000  1.00  100000  53600  1.00  1.163  .869  73300   -2600  174583
2075-76     6335.92     1030400  25520  1.00  17000  1.00  100000  53600  1.00  1.164  .868  73100   -2400  174840
2076-77     6335.83     1028100  25490  1.00  17000  1.00  100000  53600  1.00  1.164  .868  73000   -2300  175231
2077-78     6335.74     1025900  25470  1.00  17000  1.00  100000  53600  1.00  1.165  .867  72900   -2200  175456
2078-79     6335.66     1023800  25450  1.00  17000  1.00  100000  53600  1.00  1.165  .867  72800   -2100  175816
2079-80     6335.58     1021800  25420  1.00  17000  1.00  100000  53600  1.00  1.165  .867  72700   -2000  176160
2080-81     6335.50     1019800  25400  1.00  16900  1.00  100000  53600  1.00  1.166  .866  72600   -2000  176354
2081-82     6335.43     1017900  25380  1.00  16900  1.00  100000  53600  1.00  1.166  .866  72500   -1900  176683
2082-83     6335.35     1016000  25360  1.00  16900  1.00  100000  53600  1.00  1.166  .866  72500   -1900  177013
2083-84     6335.28     1014300  25340  1.00  16900  1.00  100000  53600  1.00  1.167  .865  72300   -1700  177158
2084-85     6335.22     1012600  25320  1.00  16900  1.00  100000  53600  1.00  1.167  .865  72300   -1700  177456
2085-86     6335.15     1011000  25310  1.00  16900  1.00  100000  53600  1.00  1.167  .865  72200   -1600  177736
2086-87     6335.09     1009400  25290  1.00  16900  1.00  100000  53600  1.00  1.167  .865  72200   -1600  178018
2087-88     6335.03     1008000  25270  1.00  16900  1.00  100000  53600  1.00  1.168  .864  72000   -1400  178113
2089-90*    6334.92     1005000  25240  1.00  16800  1.00  100000  53600  1.00  1.168  .864  72000   -1500  178644
2090-91     6334.86     1003600  25220  1.00  16800  1.00  100000  53600  1.00  1.168  .864  71900   -1400  178894
2092-93*    6334.76     1001100  25190  1.00  16800  1.00  100000  53600  1.00  1.169  .863  71700   -1200  179187
* DENOTES BREAK IN PRINTOUT OF YEARS WHERE CHANGE IN ELEV<=.05'

     ****END OF MONO LAKE MODEL****
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