

**A REPORT OF THE HISTORY OF
ADJUSTED VALUES OF BENCH MARKS
LOCATED IN THE VICINITY OF THE
MAIN GROUNDWATER BASIN OF THE LIVERMORE-AMADOR VALLEY**

for

ZONE 7

**Alameda County Flood Control
and
Water Conservation District**

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REPORT
HISTORY OF ADJUSTED VALUES OF BENCH MARKS
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I. Purpose of Report

The purpose of this report is to identify possible downward ground movement over the main groundwater basin of the Livermore-Amador Valley by investigating the history of published elevations of localized bench marks established and monitored by Federal and Local Government agencies.

The main groundwater basin is that part of the Livermore-Amador Valley located essentially within the valley-floor section of the Castle, Bernal, Amador, and Mocho (II) Subbasins as defined in Bulletin No. 118-2, "Evaluation of Groundwater Resources: Livermore and Sunol Valleys, State of California, Department of Water Resources," and shown in Exhibit A, attached.

This report only presents the compilation of available record data. No attempt has been made to draw any conclusions as to the physical reasons nor was any geologic analysis prepared explaining any noted changes in elevations reported.

II. History of Levelling Bench Marks and Adjustments

*Levelling is the operation in surveying performed to determine and establish elevations of points, to determine differences in elevation between points...*¹

Levelling in the United States is based upon an interconnecting network of levelling circuits tied to 26 tidal bench marks established along the Pacific, Gulf, and Atlantic Coasts. This network is referred to as the National Geodetic Vertical Datum of 1929 (NGVD 1929) and is based on an elevation of mean sea level. This network was established by the National Geodetic Survey (NGS) at which time they set bench marks, permanent points or marks, along the levelling circuits using state-of-the-art equipment and procedures to obtain a high order of accuracy in which to define the NGVD 1929.

Unfortunately, bench marks are not static and their actual elevations can, and often do, change after the establishment of initial elevations. Natural forces such as earthquakes, crustal movements, and local disturbances can affect bench mark elevations. Sinking and swelling of the ground surface caused by the removal of, and in some cases by the introduction of, subsurface materials such as water, oil and hydrocarbons, steam, and other mining operation materials can also affect the actual elevations of established bench marks. Although these changes to the bench mark elevations are generally minor in nature, over time these changes can accumulate to represent significant vertical displacements.

In order to maintain an accurate network of bench marks, NGS periodically runs new level circuits over previously established bench marks. In this manner, they can replace destroyed bench marks and either verify previous elevations or establish new elevations on those bench marks which are found intact.

During the course of running a level circuit, regardless of whether it is for the establishment of initial elevations or for checking existing elevations, negligible systematic or random errors occur in the measurement observations. In practice, these errors are assumed to be uniform in nature, and therefore, any misclosure into the final checking point is distributed evenly throughout the level circuit with each bench mark elevation being adjusted accordingly prior to publication.

¹Moffit, Francis H. and Bouchard, Harry, Surveying, 7th ed., Harper and Row, New York, 1982, Chapter 3, 19.

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Consequently, the final published elevation of each bench mark is merely a calculated estimate of the true elevation, albeit a very accurate one. In some cases a change in the published elevations of a particular bench mark may simply be the result of the adjustment of the closure errors in the respective level circuits and may not have been the result of actual physical movement of the monument itself or even a re-observation of the monument. However, if the change in elevation between publications of level circuits is significant, say more than $0.05\pm$ ft., or if after several level circuit publications a definite trend is identified, it is more than likely that a physical change in elevation has occurred.

There is no mandated schedule which dictates when or how often an established level circuit is to be redone or checked. These seem to be performed simply at the discretion and funding availability of a governing agency.

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III. Sources of Bench Mark Elevation Data

Suppliers of bench mark elevation data include but are not limited to the following sources:

1. National Geodetic Survey (NGS)
2. United States Geological Survey (USGS)
3. State, County, and City Agencies
4. Public and Private Companies

IV. Collection of Bench Mark Data

Research was conducted and inquiries were made to identify and obtain data to compile a history of continuous vertical observations of bench marks within a known level circuit running through the study area. Sources contacted included the National Geodetic Survey, the United States Geological Survey, the County of Alameda, and the City of Pleasanton. Information was obtained both verbally and in written or computer generated form from all of the agencies listed above. It was determined that the United States Geological Survey information did not contain any repetition of levelling through the study area and that the City of Pleasanton information did not extend sufficiently back in time to be of value.

The National Geodetic Survey information was relatively complete and organized and a brief tabulation could be compiled which might indicate to some degree what the ground surface over the basin was doing. This level circuit follows the former Southern Pacific Railroad right-of-way between Sunol and Livermore. The data provided covers the period from 1947 to 1965.

The County of Alameda information represents the most concentrated data with the longest history available in the study area. The data was compiled from "Vertical Control Data" adjusted elevation summary sheets published by the Coast and Geodetic Survey in 1966 and from individual bench mark sheets on file with the Alameda County Public Works Agency. This level information follows the same level circuit alignment as the National Geodetic Survey as well as other level circuit alignments. Portions of these level circuits follow the above referenced former Southern Pacific Railroad right-of-way between Sunol and Livermore, Bernal Avenue from Sunol Boulevard to Foothill Boulevard, Foothill Boulevard from Bernal Avenue to Dublin Boulevard in Dublin, Hopyard Road from the Arroyo Mocho crossing to the Arroyo Del Valle crossing, and Vineyard Avenue from Clara Lane to East Vallecitos Road. The data collected covers various periods of time from 1912 to 1974, 1947 to 1974, 1964 to 1980, 1964 to 1974, and 1938 to 1974.

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V. Analysis of Data supplied by the National Geodetic Survey

The information provided by the National Geodetic Survey (NGS) was presented in a computer generated format (see Appendix "A"). The method used by NGS to present this information is shown on page A-4 of Appendix "A" and reads as follows.

"Each of the level lines listed below has bench marks common to the base line L12201 and the first common mark is considered equivalent to the elevation of the base line. Therefore the difference is 0.00. Each subsequent common mark is the difference of the elevation from the first common mark, minus the equivalent difference on the base line, in millimeters."

The base line L12201 was run in 1947 which is the year that the subject line through the study area was established. Subsequent level runs or adjustments were made in 1958, 1960, 1964, and 1965. No further runs after 1965 were provided by NGS.

The data, which was published in meters and/or millimeters, was converted to elevations in feet relative to the common mark (Y7) on the base line. To convert meters into feet multiply meters by 3.280833; to convert millimeters into feet multiply millimeters by 0.003208. The relative elevation change in feet was tabulated between the subsequent level runs and for each time interval spanning the study period (i.e. 1947 to 1965).

The data obtained from the National Geodetic Survey (NGS) indicates that relative to base point bench mark Y7 some downward ground movement has occurred along their base line 103 (including a spur line to the former Livermore Sky Ranch Airport) within the study area for the 18 year period since it was initially established in 1947. The magnitude of this movement through 1965 (the year of their last level run) is -0.4 ft. or less according to their records.

The data set used for this analysis was compiled from the correction sheet supplied by NGS listed on page A-6 of Appendix "A".

The following paragraphs present an analysis of the individual periods between level run adjustments.

1947-1965

All but three of the initial 19 stations were recovered and measured during this 18 year period. A maximum change in elevation of -0.4 ft. or less was recorded since the 1947 initial measurements on these stations. The average change in elevation is -0.2 ft. The median change in elevation over this same period is also -0.2 ft.

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1947-1958 All initial stations were recovered and measured resulting in a maximum change in elevation of -0.2 ft. or less with an average change of -0.1 ft. and median change also of -0.1 ft. along the entire line. The majority of the higher magnitude changes (-0.2) appear to lie within the central portion of the main groundwater basin.

1958-1960 All but eight of the initial stations were recovered and measured. A maximum change in elevation of -0.1 ft. or less was recorded since the 1958 measurement; however, the bench marks were predominately static during this two year period with the average and median change resulting in 0.0 ft.

1960-1964 In 1964 a partial level circuit was run which included only the first five stations. Only the last two stations are within the main groundwater basin boundary. The results of this run indicated that these stations had actually risen an average of 0.2 ft. or less in the four year period since 1960. However, when these same stations were measured one year later, for the most part they apparently had returned to the elevations previously published in 1960.

1964-1965 The 1965 level circuit was run along the entire initial line, with all but three of the initial stations recovered. As noted above, this included the five stations which were measured in 1964. In comparing the measurements of these five stations, a negative change in elevation over the one year period was detected which was essentially comparable to the positive change in elevation of the same five stations over the previous four year period. Although the data suggests that the ground may have risen 0.2 ft. between 1960 and 1964, and then receded or lowered the same 0.2 ft. by 1965, one could question the validity of the 1965 data since it is tabulated out of sequence on both of the data sheets provided by NGS (see pages 11d through 11f). Also, it is unclear why the 1965 level circuit run was only partially completed.

1958-1965 The eight stations which had not been recovered since 1958 were recovered and measured in 1965, resulting in an average change in elevation of -0.2 ft. or less with the median elevation change of -0.2 ft. The maximum elevation change noted was -0.3 ft.

1960-1965 Disregarding the 1964 measurements, an analysis of the five year period between 1960 and 1965 indicates an average and median change in elevation of -0.1 feet. A maximum change of -0.2 ft. was observed at two stations (LVRM WB RM and Q832) with all other stations showing -0.1 ft. change, or in a few cases, no change since 1960.

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PORTION OF NGS LINE 103 - NILES TO MIDWAY
FROM 2.7 MILES NORTH OF SUNOL (B8) TO
3.7 MILES WEST OF LIVERMORE (V832)
ALONG THE SOUTHERN PACIFIC RAILROAD
(INCLUDING SPUR LINE TO LIVERMORE SKY RANCH AIRPORT)

YEAR LINE	1947 L12201	1958 L16636/A	1960 L18119/21	1964 L19618/1	1965 L20139	(2) Baseline Distance (Km)
BM DESIGNATION	(1) Elevation (Feet)					
Y7 COMMON MARK ^						3.05
B8 ^	302.5	302.6	302.6	302.6	302.5	14.92
F832 ^	332.9	332.7	332.6	332.7	332.5	16.37
G832 ^	337.3	337.2	337.1	337.3	337.1	17.52
C8	337.1	337.0	337.0	337.2	337.0	18.58
H832	352.2	352.1	352.1	352.3	352.1	19.08
LVRM WB RM	359.9	359.7	359.7	--	359.5	20.89
LVRM WB	359.6	359.4	359.3	--	359.2	20.90
D8	367.3	367.2	367.1	--	367.0	21.25
LVRM WB AZ	370.5	370.3	370.3	--	--	21.42
K832	414.7	414.6	414.6	--	414.5	25.58
LVRM EB AZ	436.6	436.5	436.5	--	--	26.52
LVRM EB	459.8	459.8	459.8	--	459.7	26.95
E8 1940	460.7	460.7	--	--	--	27.03
Q832	467.3	467.2	467.2	--	467.0	29.40
S832	439.2	439.2	--	--	439.1	30.91
T832	447.6	447.6	--	--	447.4	31.55
486.213B USGS	486.1	486.0	486.0	--	485.8	28.82
M832	491.9	491.8	--	--	491.6	29.23
P832 ^	533.6	533.5	--	--	533.4	31.00
N832 ^	536.8	536.7	--	--	533.4	32.31
V832 ^	562.3	562.3	--	--	562.3	34.86

(1) Elevations are derived from data supplied by the National Geodetic Survey, Rockville, Maryland, January 7, 1993.

(2) Distance is along the baseline from the start of Line 103 at Niles

-- Data not available

^ Station outside main groundwater basin boundary

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FROM 2.7 MILES NORTH OF SUNOL (B8) TO
3.7 MILES WEST OF LIVERMORE (V832)
ALONG THE SOUTHERN PACIFIC RAILROAD
(INCLUDING SPUR LINE TO LIVERMORE SKY RANCH AIRPORT)

Change	ADJUSTMENT PERIOD (EPOCH)					Total
	1947 Base	47-58	58-60	60-64	64-65 (60-65) [58-65]	1947-1965 (1947-1960)
BM DESIGNATION	Relative Elevation Change (Feet) Year to Year					
B8 ^	*	0.1	0.0	0.0	-0.1	0.0
F832 ^	*	-0.2	-0.1	0.1	-0.2	-0.4
G832 ^	*	-0.1	-0.1	0.2	-0.2	-0.2
C8	*	-0.1	0.0	0.2	-0.2	-0.1
H832	*	-0.1	0.0	0.2	-0.2	-0.1
LVRM WB RM	*	-0.2	0.0	--	(-0.2)	-0.4
LVRM WB	*	-0.2	-0.1	--	(-0.1)	-0.4
D8	*	-0.1	-0.1	--	(-0.1)	-0.3
LVRM WB AZ	*	-0.2	0.0	--	--	(-0.2)
K832	*	-0.1	0.0	--	(-0.1)	-0.2
LVRM EB AZ	*	-0.1	0.0	--	--	(-0.1)
LVRM EB	*	0.0	0.0	--	(-0.1)	-0.1
E8 1940	*	0.0	--	--	--	0.0
Q832	*	-0.1	0.0	--	(-0.2)	-0.3
S832	*	0.0	--	--	[-0.1]	-0.1
T832	*	0.0	--	--	[-0.2]	-0.2
486.213B USGS	*	-0.1	0.0	--	[-0.2]	-0.3
M832	*	-0.1	--	--	[-0.2]	-0.3
P832 ^	*	-0.1	--	--	[-0.1]	-0.2
N832 ^	*	-0.1	--	--	[-0.3]	-0.4
V832 ^	*	0.0	--	--	[0.0]	0.0
AVERAGE/MEDIAN		-0.1/-0.1	0.0/0.0	0.1/0.2	-0.2/-0.2 (-0.1)/(-0.1) [-0.2]/[-0.2]	-0.2/-0.2 (-0.2)/(-0.2)

* Base year for bench mark

-- Data not available

^ Station outside main groundwater basin boundary

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**VI. Analysis of Data compiled from records of
Alameda County Public Works Agency**

The information collected from Alameda County Public Works Agency files include data from Coast and Geodetic Survey, "Vertical Control Data" Summary Sheets dated November 1966 (See Appendix "B"). The 1957, 1961, 1974 and 1980 elevation values were taken from individual bench mark sheets on file with Alameda County Public Works Agency. The individual bench mark sheets on file at the County office show the last available adjusted elevation for the bench mark, the adjustment date, and the datum which the elevation is based upon. Each individual bench mark sheet also includes past adjusted elevations and past adjustment dates for the bench mark. The sources of the past adjusted elevations are not shown. A comparison of the adjusted elevations and adjustment dates confirms that all of these sources are on the same datum. No explanation for the elevation changes is given. The last levels run and adjustments made by the Alameda County Public Works Agency in the Livermore Valley were in 1974.

The data compiled from the Coast and Geodetic Survey (CGS) and Alameda County Public Works Agency (ACPWA) records generally support the National Geodetic Survey (NGS) results indicating a mostly minor negative change in elevation of bench marks within the valley. The maximum change in elevation according to the CGS, and ACPWA data is -0.4 ft. or less along that portion of Line 103 within the study area.

As indicated earlier by the NGS data, the majority of the larger magnitude downward ground movement appears to be located in the middle of the run and lying within the central portion of the main groundwater basin. It is also apparent from the data presented on page 11b that the largest change was observed in 1958 with a maximum change in elevation of -0.3 ft. and an average of -0.1 ft. and a median change of -0.1 ft. Subsequent level run adjustments resulted in virtually no change in elevation for the years of 1960, 1961 and 1964, based on each year's average readings, and only a slight downward ground movement (less than -0.1 ft.) in 1965. However, the level adjustment made in 1974 identified a positive change in elevation of 0.1 ft. over the previous nine year period since 1965.

In addition to Line 103, which was the same level run provided by NGS, ACPWA records also contained data on several intermediate level runs within the study area. This data is tabulated on pages 11c through 11h and is summarized as follows:

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Spur Line to Former Livermore Sky Ranch Airport

Four bench marks were established along North L Street, Junction Avenue and at the former Livermore Sky Ranch Airport. These stations were established in 1947 and 1958 as shown on Page 11c. The data indicates that an average change in elevation (in a ten year period) of +0.1 ft. was observed in 1957 with an average change of -0.1 ft. observed in the following year (1958). The two periods of three years (1958 to 1961) and four years (1961 to 1965) following 1958 indicate an observed average change in elevation of -0.1 ft. for each period. The last observed elevation in 1965 shows an average elevation change of -0.1 ft. with two stations returning to their initial elevations and two stations showing downward ground movement of -0.2 feet. Three of the stations were reported to be destroyed in 1974. No additional elevation data was found for the remaining station (T832) past 1965.

Line "D" Bench marks were established at ten stations along Bernal Avenue between Sunol Boulevard and Foothill Road. These stations were established at varying dates between 1947 and 1965 as shown on page 11d. The data indicates that an average change in elevation of -0.1 ft. was observed in June of 1965 which for the most part represented a period of six years. Over the next nine years an average positive change in elevation of 0.2 ft. was observed as indicated by the 1974 adjustment. Overall, it appears that the 1974 measurements were relatively consistent with the initial readings, most of which were established in 1959.

Line "E" This level run study which covers a fairly brief period of only ten years includes three bench marks along Hopyard Road between Arroyo Mocho and Arroyo Valle. Over the ten year period which culminated in 1974, an average positive change in elevation of 0.3 ft. was observed. This positive change in elevation is consistent with the change in Line "D" over the same ten year period.

Line "J" In 1938 five stations were established along Vineyard Avenue between Clara Lane and East Vallecitos Road and three stations along Arroyo Road from Wetmore Road to the Arroyo Mocho. These points lie near the foothills along the southerly and easterly boundary of the main groundwater basin. Three of the stations are very near the basin boundary, three stations are well within the basin boundary, and two stations are just outside of the basin boundary (Ala. Co. 123, Ala. Co. 122). In 1974, thirty-six years later, the first and only found published check of the stations was made, at which time all initial stations were recovered. For all intents and purposes, the 1974 readings were identical to the 1938 readings except for station Ala. Co. 21 which showed a negative elevation change of almost 0.2 ft. indicating that there has been no change in elevation over the thirty-six year

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period except as noted. However, it is important to note that since no intermediate measurements were made during the thirty-six year hiatus, we cannot be certain that movement has not occurred. As in the case of Line "D", if measurements had been made in 1958, some movement may have been detected, whereupon conditions may have returned to the initial state by 1974. This, of course, is only conjecture on our part.

NGS Line 118 (portion of Alameda County Line "JJ")

NGS Line 118 begins in Livermore and runs southeasterly along South Livermore Avenue, southeasterly and easterly along Tesla Road and southeasterly along Mines Road. Only two stations on this run show any history of elevation adjustments. The NGS run of Line 118 was run in 1961 but elevations were obtainable for these stations prior to this date. The initial elevations presented on Page 11g are assumed to be at the time that the station was established in 1939 and 1940 or shortly thereafter. Station 118 (Ala. Co.) 1939 had an adjusted elevation during 1959 resulting in an elevation change of -0.1 ft. This station along with Station 163 (Ala. Co.) 1940 also had an adjusted elevation during 1961 as noted resulting in elevation change of -0.1 ft. for the period of 1959 to 1961 and 1940 to 1961, respectively. Station 118 (Ala. Co.) 1939 shows an elevation change of -0.2 ft. for the period of 1939 to 1961.

Line "C" As in the case of Line "E", this level circuit's brief history of only ten years does not result in significant changes in elevation being observed. This line, which runs along Foothill Boulevard between Bernal Avenue and Dublin Boulevard, lies outside the boundaries of the main basin with the exception of Stations FOOT-BERN and J-972, and is included as a control line. Line "C" includes eight stations initially established in 1964 and 1965 and was rerun in 1974 with five of the eight stations being recovered. Virtually no change in elevation was observed at that time. In 1980 two of the original stations were recovered, and once again, no change in elevation was observed.

PORTION OF NGS LINE 103 - MILES TO MIDWAY
FROM 2.7 MILES NORTH OF SUNOL (B8) TO
3.7 MILES NORTHEAST OF LIVERMORE (V832)
ALONG THE SOUTHERN PACIFIC RAILROAD

(1) Elevations are from Vertical Control Data adjusted elevation summary sheets supplied by the Coast and Geodetic Survey - November 1968 copied from Alameda County Public Works Agency working files. 1957, 1961 and 1974 elevation values were taken from individual bench mark sheets on file with Alameda County Public Works Agency.

(2) Distance is along the baseline from the start of Line 103 at Niles

Data not available

Station outside main groundwater basin boundary

PORTION OF NGS LINE 103 - NILES TO MIDWAY
FROM 2.7 MILES NORTH OF SUNOL (98) TO
3.7 MILES NORTHEAST OF LIVERMORE (V892)
ALONG THE SOUTHERN PACIFIC RAILROAD

Data not available

Base year for bench mark elevation

Station outside main groundwater basin boundary

SPUR LINE OFF OF NGS LINE 103
NORTH L STREET, JUNCTION AVENUE
TO FORMER LIVERMORE SKY RANCH AIRPORT

ADJUSTMENT PERIOD (EPOCH)AVERAGE/MEDIAN

(2) Distance is along the baseline from the start of Line 103 at Niles.

*** Base year for bench mark elevation**

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PORTION OF ALAMEDA COUNTY LINE "D" - BERNAL AVE., SUNOL BLVD. TO FOOTHILL BLVD.

BM DESIGNATION	1947	1948	1954	1957	1958	1959	1960	1961	1964	FEB 1965	JUNE 1965	1966	1974
					(1) ELEVATION (FEET)								
C8	337.2	—	—	337.3	337.1	—	337.1	—	337.0	337.0	337.1	—	337.2
G	—	—	—	—	—	338.5	—	—	—	—	338.4	—	—
F	—	—	—	—	—	333.1	—	—	—	—	332.9	—	333.2
E	—	—	—	—	—	332.1	—	—	—	—	331.9	—	332.1
D	—	—	—	—	—	323.9	—	—	—	—	323.8	—	—
C	—	—	—	—	—	325.2	—	—	—	—	325.1	—	—
B	—	—	—	—	—	325.2	—	—	—	—	325.1	—	325.3
7Az	—	—	—	—	—	—	—	—	—	—	321.3	—	321.5
ALA CO	—	—	—	—	—	—	—	—	—	—	323.9	—	324.0
FOOT-BERN	—	—	—	—	—	—	—	—	—	—	348.1	—	348.2

11d

ADJUSTMENT PERIOD (EPOCH)

BM DESIGNATION	1947	1948	1954	1957	1958	1959	1960	1961	1964	FEB 1965	JUNE 1965	1966	1974	TOTAL CHANGE
					RELATIVE ELEVATION CHANGE (FEET) YEAR TO YEAR									
C8	*	—	—	0.1	-0.2	—	0.0	—	-0.1	0.0	0.1	—	0.1	0.0
G	—	—	—	—	—	*	—	—	—	—	-0.1	—	—	-0.1
F	—	—	—	—	—	*	—	—	—	—	-0.2	—	0.3	0.1
E	—	—	—	—	—	*	—	—	—	—	-0.2	—	0.2	0.0
D	—	—	—	—	—	*	—	—	—	—	-0.1	—	—	-0.1
C	—	—	—	—	—	*	—	—	—	—	-0.1	—	—	-0.1
B	—	—	—	—	—	*	—	—	—	—	-0.1	—	0.2	0.1
7Az	—	—	—	—	—	*	—	—	—	—	*	—	0.2	0.2
ALA CO	—	—	—	—	—	*	—	—	—	—	*	—	0.1	0.1
FOOT-BERN	—	—	—	—	—	*	—	—	—	—	*	—	0.1	0.1
AVERAGE/MEDIAN	—	—	—	0.1/-	-0.2/-	—	0.0/-	—	-0.1/-	0.0/-	-0.1/-0.1	—	0.2/0.2	0.0/0.1

(1) Elevations are from Vertical Control Data adjusted elevation summary sheets supplied by the Coast and Geodetic Survey - November 1966 copied from Alameda County Public Works Agency working files. 1957, 1961, and 1974 elevation values were taken from individual bench mark sheets on file with Alameda County Public Works Agency.

— Data not available

* Base year for bench mark elevation

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PORTION OF ALAMEDA COUNTY LINE "E" - HOPYARD ROAD, ARROYO MOCHO TO ARROYO VALLE

YEAR:

BM DESIGNATION

(1) ELEVATION (FEET)

	1984	FEB 1985	JUNE 1965	1966	1974
C-972	332.8	---	332.8	---	---
C-972 RESET 1967	---	---	330.5	---	330.8
A-972 C&GS 1964	345.1	---	345.0	---	345.2

ADJUSTMENT PERIOD (EPOCH)

YEAR:

BM DESIGNATION

RELATIVE ELEVATION CHANGE (FEET) YEAR TO YEAR

	1984	FEB 1985	JUNE 1965	1966	1974	TOTAL CHANGE
C-972	*	---	0.0	---	---	0.0
C-972 RESET 1967	---	---	*	---	0.3	0.3
A-972 C&GS 1964	*	---	-0.1	---	0.2	0.1
AVERAGE/MEDIAN	---	---	0.0/0.0	---	0.3/0.2	0.1/0.1

(1) Elevations are from Vertical Control Data adjusted elevation summary sheets supplied by the Coast and Geodetic Survey - November 1966 and copied from individual bench mark sheets on file with Alameda County Public Works Agency.

--- Data not available

* Base year for bench mark elevation

PORTION OF ALAMEDA COUNTY LINE "J" - VINEYARD AVENUE,
CLARA LANE TO EAST VALLECITOS ROAD AND ARROYO ROAD, WETMORE ROAD TO WEST 1ST STREET

11fRELATIVE ELEVATION CHANGE (FEET) YEAR TO YEAR

(1) Elevations are copied from Individual bench mark sheets on file with Alameda County Public Works Agency.

Data not available

* Base year for bench mark elevation

Station outside main groundwater basin boundary

**REPORT OF THE HISTORY OF ADJUSTED VALUES OF BENCH MARKS
LOCATED IN THE VICINITY OF THE MAIN GROUNDWATER BASIN OF THE LIVERMORE-AMADOR VALLEY**

PORTION OF NGS LINE 118 - SOUTHEAST
ALONG TESLA ROAD FROM LIVERMORE

BM DESIGNATION	1939	1940	1948	1954	1957	1959	1960	1961
ALA CO 118 1939	597.2	---	---	---	---	597.1	---	597.0
ALA CO 163 1940	---	633.8	---	---	---	---	---	633.7

(1) ELEVATION (FEET)

ADJUSTMENT PERIOD (EPOCH)

YEAR:	1939	1940	1948	1954	1957	1959	1960	1961	TOTAL CHANGE
-------	------	------	------	------	------	------	------	------	--------------

BM DESIGNATION

ALA CO 118 1939	*	---	---	---	---	-0.1	---	-0.1	-0.2
ALA CO 163 1940	*	---	---	---	---	---	---	-0.1	-0.1
AVERAGE/MEDIAN						-0.1/-	---	-0.1/-0.1	-0.2/-0.2

(1) ELEVATION (FEET)

(1) Elevations are copied from individual bench mark sheets on file with Alameda County Public Works Agency.

— Data not available

* Base year for bench mark elevation

^ Station outside main groundwater basin boundary

PORTION OF ALAMEDA COUNTY LINE "C" - FOOTHILL BLVD., BERNAL AVE. TO DUBLIN BLVD.
PORTIONS OF LINE "C" IS OUTSIDE THE MAIN GROUNDWATER BASIN AND IS INCLUDED AS A CONTROL LINE

ADJUSTMENT PERIOD (EPOCH)

(1) Elevations are copied from individual bench mark sheets on file with Alameda County Public Works Agency.

Station outside main groundwater basin boundary

REPORT

HISTORY OF ADJUSTED VALUES OF BENCH MARKS
MAIN GROUNDWATER BASIN, LIVERMORE-AMADOR VALLEY

VII. Summation of Report

The first point which must be considered in summarizing this report is in the consistency of the data utilized. In reviewing the year to year changes in each set of data, it appears that while minor fluctuations exist within the measurements, the data is consistent and an overall trend is apparent. Beginning at the earlier initial readings, the data suggest that minor downward ground movement on the order of magnitudes of an average of -0.2 ft. or less was occurring over the years through 1965. The maximum change during this period was -0.4 ft. It appears though that a majority of this downward ground movement was observed by 1958; however, downward ground movement did continue to occur through the mid 1960's. The 1974 measurements on the other hand seem to indicate that upward ground movement had occurred over the last decade (1965-1974) on the order of magnitudes of an average of 0.2 ft. or less and that the basin floor had returned to its original elevation observed in the earliest readings. This is apparent in that the later readings are consistent with the earlier initial readings. The data for Line "D" supports this with an average negative change between 1959 and 1965 of -0.1 ft., and a stronger positive change in the 1974 average measurements of 0.2 ft. The data for Line "E" shows the same average positive change of 0.3 ft. or less over the last ten years, and the Line "J" data shows a consistent elevation for the initial and ending measurements for most of the stations. NGS Line 118 also shows an average negative elevation change for the period of 1939/1940 to 1961 of -0.2 feet. Line "C" was not established until 1964/1965 and appears to have remained static through 1974/1980. Although data presented here dates from 1912 to 1980, a period of 68 years, the bulk of the data dates from the following periods: 1947 to 1974, 27 years; 1947 to 1965, 18 years; 1959 to 1974, 15 years; and 1964 to 1974, 10 years. Of the 58 bench mark stations presented, 17 are outside the main groundwater basin boundary leaving 41 either inside the main groundwater basin or near the boundary.

REPORT

HISTORY OF ADJUSTED VALUES OF BENCH MARKS
MAIN GROUNDWATER BASIN, LIVERMORE-AMADOR VALLEY

IX. Bibliography/References

ACSM & ASCE, Definitions of Surveying and Associates Terms, ACSM 1978 Rev.

Buckner, R.B., Surveying Measurements and their Analysis, 1st ed., Landmark Enterprises, Rancho Cordova, California, 1983, Chapter 1, 3, 7.

Moffit, Francis H. and Harry Bouchard, Surveying, Harper and Row, New York, 1982, Chapter 3, 19.

REPORT

HISTORY OF ADJUSTED VALUES OF BENCH MARKS
MAIN GROUNDWATER BASIN, LIVERMORE-AMADOR VALLEY

X. Appendix "A"

Please see following pages (A-1 through A-6)

The following computer printouts were provided by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geodetic Survey N/CG13, Rockville, Maryland. These printouts represent the input commands (page A-1) and output results (pages A-1 - A-4) for their elevation reference comparison program "new-minus-old". Page A-6 is a rerun of the program to correct an input error for bench mark G832 for comparison of years 1965 to 1964. The chart on page A-5 shows a graphic representation of the movement of these bench marks relative to bench mark "Y7".

The data supplied on page A-6 was used to compile the charts listed on pages 7a and 7b. The data supplied on page A-4 was not used for this report and is included here for reference only.

```

10:37:48 ( 3.93) NEW_MINUS_OLD Version 1.90
10:37:48 ( 4.05) Retrieving Data
10:37:48 ( 4.67) LOGIN TO SQL
10:37:48 ( 8.49) READY TO GET OBSERVATIONAL DATA
10:38:18 ( 12.60) OBS FOR L12201 RETRIEVED
10:38:22 ( 16.44) READY TO GET BM DATA
10:41:02 ( 32.94) L12201 BM DATA RETRIEVED
10:41:02 ( 32.95) LINE ORDER BEGINS
10:41:02 ( 33.12) LINE ORDER COMPLETED
10:41:03 ( 33.58) LOGIN TO SQL
10:41:22 ( 34.48) READY TO GET OBSERVATIONAL DATA
10:41:42 ( 42.82) OBS FOR L16636/A RETRIEVED
10:41:54 ( 48.78) READY TO GET BM DATA
10:45:39 ( 80.75) L16636/A BM DATA RETRIEVED
10:45:39 ( 80.75) LINE ORDER BEGINS
10:45:39 ( 81.07) LINE ORDER COMPLETED
10:45:44 ( 84.06) LOGIN TO SQL
10:46:00 ( 84.91) READY TO GET OBSERVATIONAL DATA
10:46:04 ( 87.89) OBS FOR L18118/21 RETRIEVED
10:46:07 ( 90.44) READY TO GET BM DATA
10:47:15 ( 100.70) L18118/21 BM DATA RETRIEVED
10:47:15 ( 100.71) LINE ORDER BEGINS
10:47:15 ( 100.79) LINE ORDER COMPLETED
10:47:17 ( 102.17) LOGIN TO SQL
10:47:36 ( 103.04) READY TO GET OBSERVATIONAL DATA
10:48:09 ( 122.78) OBS FOR L20139 RETRIEVED
10:48:29 ( 136.72) READY TO GET BM DATA
11:01:20 ( 237.80) L20139 BM DATA RETRIEVED
11:01:20 ( 237.80) LINE ORDER BEGINS
11:01:25 ( 239.16) LINE ORDER COMPLETED
11:01:56 ( 246.63) LOGIN TO SQL
11:02:26 ( 247.52) READY TO GET OBSERVATIONAL DATA
11:02:46 ( 252.58) OBS FOR L19618/1 RETRIEVED
11:02:58 ( 258.66) READY TO GET BM DATA
11:06:40 ( 275.45) L19618/1 BM DATA RETRIEVED
11:06:40 ( 275.45) LINE ORDER BEGINS
11:06:41 ( 275.61) LINE ORDER COMPLETED

```

Source of Data:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey N/CG13
Rockville, Maryland, January 7, 1993

THE FOLLOWING CORRECTIONS WERE APPLIED TO THE OBSERVATIONS

ORTHOMETRIC; ROD; LEVEL; TEMPERATURE; ASTRO; REFRACTION; MAGNETIC

LINES O/C AGENCY YR

L12201 12 NGS 1947
L18636/A 12 NGS 1958
L18119/21 12 NGS 1860
L20139 12 NGS 1965
L18618/1 12 NGS 1964

THE FOLLOWING DATA ARE FOR THE BASE LINE L12201 1947

ACRN	DESIGNATION	AND STABILITY	HEIGHT (m)	DIST (Km)	SPUR LEVEL
HS3381	F 148	B	22.61600	0.00	0
HS3380	X 7	D	26.32322	0.52	0
HS3547	Y 7	B	37.87626	3.05	0
HS3544	D 148	B	48.91518	4.30	0
HS3543	A 832	D	58.54579	5.64	0
HS3542	E 148	B	62.38817	7.26	0
HS3541	B 832	D	66.45663	8.81	0
HS3540	A 8	B	68.72080	9.46	0
HS3538	C 832	B	79.47178	10.72	0
HS3537	D 832	D	81.63355	11.94	0
HS3536	E 832	D	84.84578	13.22	0
HS3535	B 8	B	92.21722	14.92	0
HS3534	F 832	B	101.46260	16.37	0
HS3532	G 832	B	102.80904	17.52	0
HS3531	C 8	C	102.75522	18.58	0
HS3530	H 832	C	107.34564	19.08	0
HS3528	LIVERMORE WEST BASE RM 2	C	109.71264	20.89	0
HS3526	LIVERMORE WEST BASE	C	109.59765	20.90	0
HS4315	LIVERMORE WEST BASE RM 1	C	109.85044	20.92	0
HS3525	D 8	B	111.85321	21.25	0
HS3523	LIVERMORE WEST BASE AZ	D	112.91558	21.42	0
HS3521	J 832	B	117.34448	23.29	0
HS3519	L 832	D	117.29652	24.11	0
HS3518	K 832	D	126.40086	25.58	0
HS3516	LIVERMORE EAST BASE AZ	C	133.06411	26.52	0
HS3513	LIVERMORE EAST BASE	C	140.16153	26.95	0
HS3514	LIVERMORE EAST BASE RM 2	C	139.32908	26.97	1
HS3512	LIVERMORE EAST BASE RM 1	C	139.37032	26.97	0

Source of Data:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey N/CG13
Rockville, Maryland, January 7, 1993

ACRN	DESIGNATION	AND	STABILITY	HEIGHT (m)	DIST (Km)	SPUR LEVEL
HS3510	E 8 RESET 1940		D	140.43056	27.03	0
HS3505	Q 832		C	142.43500	29.40	1
HS4167	R 832			134.81155	30.80	1
HS3508	S 832		C	133.86830	30.91	1
HS3509	T 832		D	136.42761	31.55	1
HS3504	486.213 B USGS		D	148.16292	28.82	0
HS3503	M 832		B	149.94620	29.23	1
HS4166	531.049			161.82347	30.99	0
HS3502	P 832		B	162.64695	31.00	0
HS3501	N 832		B	163.62986	32.31	0
HS3499	U 832		D	167.31133	33.74	0
HS3497	V 832		B	171.39651	34.86	0
HS3486	Y 737		C	181.67552	36.00	0
HS3485	X 737		B	195.28049	37.05	0
HS3484	W 737		A	209.29888	38.43	0
HS3483	I 8		B	218.27319	39.53	0
HS3482	738.899		D	225.50069	41.77	0
HS3481	K 8		B	219.22778	42.47	0

Source of Data:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey N/CG13
Rockville, Maryland, January 7, 1993

Each of the level lines listed below has bench marks common to the base line L12201 and the first common mark is considered equivalent to the elevation of the base line. Therefore the difference is 0.00. Each subsequent common mark is the difference of the elevation from the first common mark, minus the equivalent difference on the base line, in millimeters.

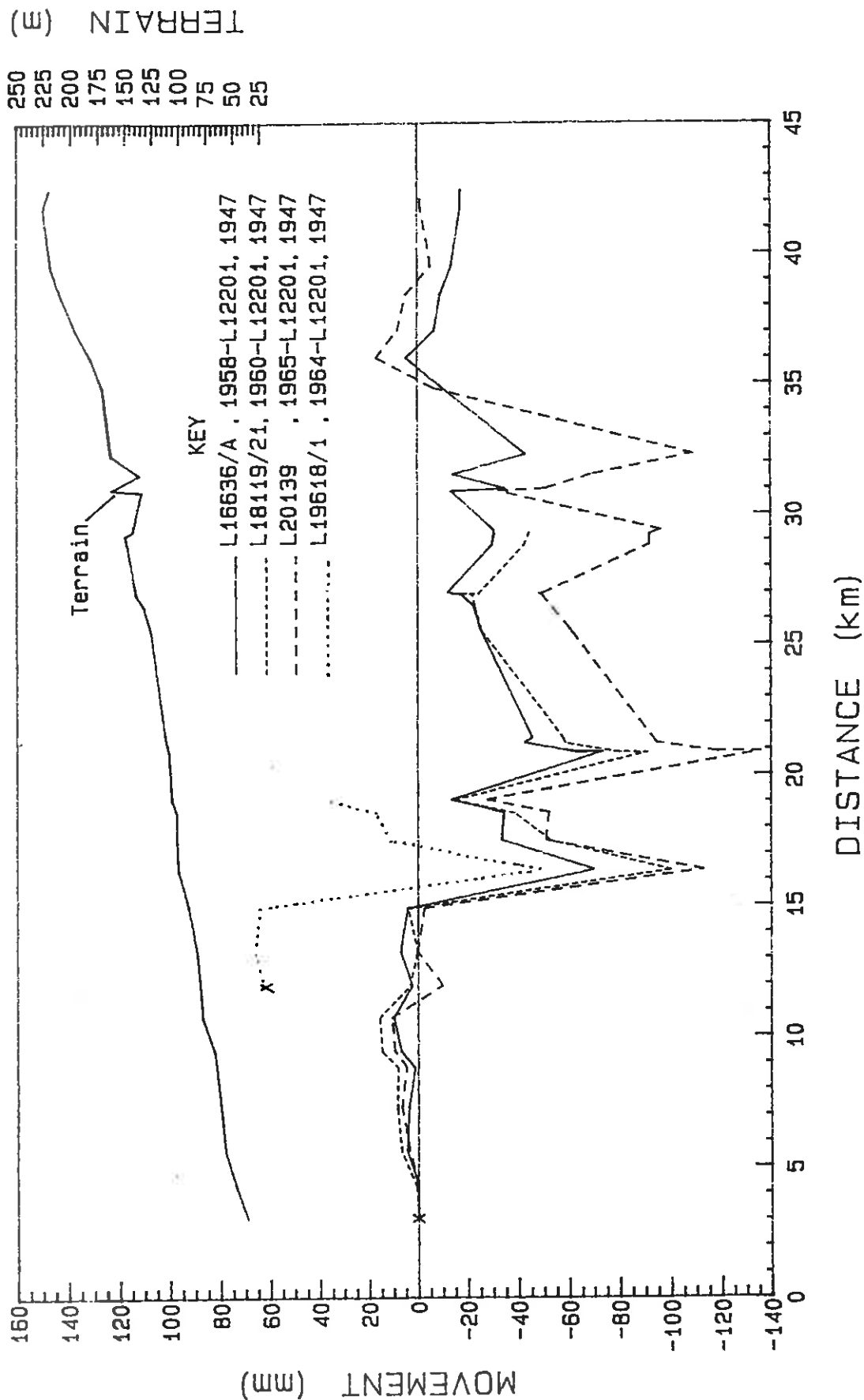
DESIGNATION AND STABILITY	DIST	1958	1960	1965	196A	19618/1
Y 7	B	3.05	0.00	0.00	0.00	
D 148	B	4.30	-0.10	0.10	0.10	
A 832	D	5.64	4.54	7.09	3.58	
E 148	B	7.26	3.59	8.73	6.73	
B 832	D	8.81	1.08	8.10	4.51	
A 8	B	9.46	7.04	14.92	9.63	
C 832	B	10.72	9.91	15.88	10.74	
D 832	D	11.94	2.12	3.21	-9.96	0.00
E 832	D	13.22	7.06	0.44	0.11	4.21
B 8	B	14.92	3.99	-4.37	1.90	1.90
F 832	B	16.37	-70.23	-100.13	-112.92	-111.10
G 832	B	17.52	-33.31	-52.42	-50.85	-51.57
C 8	C	18.58	-34.58	-38.21	-52.26	-45.09
H 832	C	19.08	-13.68	-14.79	-27.74	-25.44
LIVERMORE WEST BASE RM 2C	C	20.08	-73.73	-91.13	-135.88	
LIVERMORE WEST BASE	C	20.90	-63.21	-79.78	-118.53	
D 8	B	21.25	-32.65	-58.32	-94.33	
LIVERMORE WEST BASE AZ	D	21.42	-45.82	-57.86		
K 832	D	25.58	-25.17	-25.11	-60.51	
LIVERMORE EAST BASE AZ	C	26.52	-22.22	-22.65		
LIVERMORE EAST BASE	C	26.95	-17.12	-21.53	-48.93	
LIVERMORE EAST BASE RM 2C	C	26.97	-19.85	-20.85	-48.34	
LIVERMORE EAST BASE RM 1C	C	26.97	-14.40	-24.47	-49.73	
E 8 RESET 1940	D	27.03	-12.30	-12.30		
Q 832	C	28.40	-30.57	-44.91	-96.32	
S 832	C	30.91	-13.52		-32.42	
T 832	D	31.55	-14.36		-70.37	
486.213 B USGS	D	28.82	-30.01	-42.49	-91.99	
M 832	B	28.23	-30.91		-92.11	
P 832	B	31.00	-35.13		-51.41	
N 832	B	32.31	-43.14		-108.96	
V 832	B	34.86	-10.07		-6.22	
Y 737	C	36.00	4.70		16.77	
X 737	B	37.05	-7.15		7.93	
W 737	A	38.43	-9.54		4.50	
I 8	B	39.53	-14.02		-6.55	
739.899	D	41.77	-17.74		-1.05	
K 8	B	42.47	-17.58		-1.15	

-48.0

Source of Data:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey N/CG13
Rockville, Maryland, January 7, 1993

NILES TO MIDWAY CALIFORNIA



		1947	1958	1960	1965	1964
11 V 7	3.05	37.8763	0.00	0.00	0.00	
21 D 148	4.30	48.9152	-0.10	1.12	0.09	
31 A B32	5.64	58.5458	4.54	7.08	3.58	
41 E 148	7.26	62.3882	3.59	8.73	6.73	
51 B B32	8.81	66.4566	1.08	8.09	4.51	
61 A 8	9.46	68.7208	7.04	14.91	9.63	
71 C B32	10.72	79.4718	9.91	15.85	10.74	
81 D B32	11.94	81.6336	2.12	3.20	-9.97	63.10
91 E B32	13.22	84.6459	7.06	0.43	0.11	67.30
101 B 8	14.92	92.2172	3.99	4.37	-2.81	64.99
111 F B32	16.37	101.4626	-70.23	-100.13	-112.92	-48.00
121 G B32	17.52	102.8090	-33.31	-52.43	-50.86	11.55
131 C 8	18.58	102.7552	-34.58	-38.22	-52.26	18.01
141 H B32	19.08	107.3456	-13.68	-14.79	-27.74	37.65
151 LIVERMORE WEST BASE RM	20.89	109.7126	-73.73	-91.14	-135.88	
161 LIVERMORE WEST BASE	20.90	109.5976	-65.21	-79.78	-118.53	
171 D 8	21.25	111.9532	-42.65	-58.32	-94.34	
181 LIVERMORE EAST BASE AZ	21.42	112.9156	-45.82	-57.66		
191 K B32	25.58	126.4007	-25.17	-25.11	-60.51	
201 LIVERMORE EAST BASE AZ	26.52	133.0641	-22.21	-22.65		
211 LIVERMORE EAST BASE	26.95	140.1615	-17.12	-21.53	-40.95	
221 LIVERMORE EAST BASE RM	26.97	139.3291	-19.84	-20.85	-49.84	
231 LIVERMORE EAST BASE RM	26.97	139.3703	-14.39	-24.47	-49.73	
241 E 8 RESET 1940	27.03	140.4306	-12.30			
251 O B32	29.40	142.4350	-30.57	-44.91	-56.32	
261 S B32	30.91	133.8688	-13.52		-32.42	
271 T B32	31.55	134.4278	-14.56		-78.37	
281 464.213 6 0888	28.62	148.1629	-30.01	-42.49	-91.99	
291 U B32	29.23	149.9462	-30.51		-82.11	
301 P B32	31.00	162.6469	-35.13		-51.41	
311 W B32	32.31	163.6299	-43.14		-108.96	
321 V B32	34.86	171.3965	-10.07		-6.22	
331 Y 737	36.00	181.6755	4.70		15.77	
341 X 737	37.05	195.2835	-7.15		7.43	
351 W 737	38.43	209.2969	-9.54		4.50	
361 Z 8	39.53	219.2732	-14.02		-5.58	
371 739.699	41.77	225.5007	-17.74		-1.05	
381 K 8	42.47	219.2278	-17.58		-1.16	

Source of Data:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Geodetic Survey N/CG13
Rockville, Maryland, January 7, 1993

REPORT

HISTORY OF ADJUSTED VALUES OF BENCH MARKS
MAIN GROUNDWATER BASIN, LIVERMORE-AMADOR VALLEY

XI. Appendix "B"

Please see following pages (B-1 through B-6)

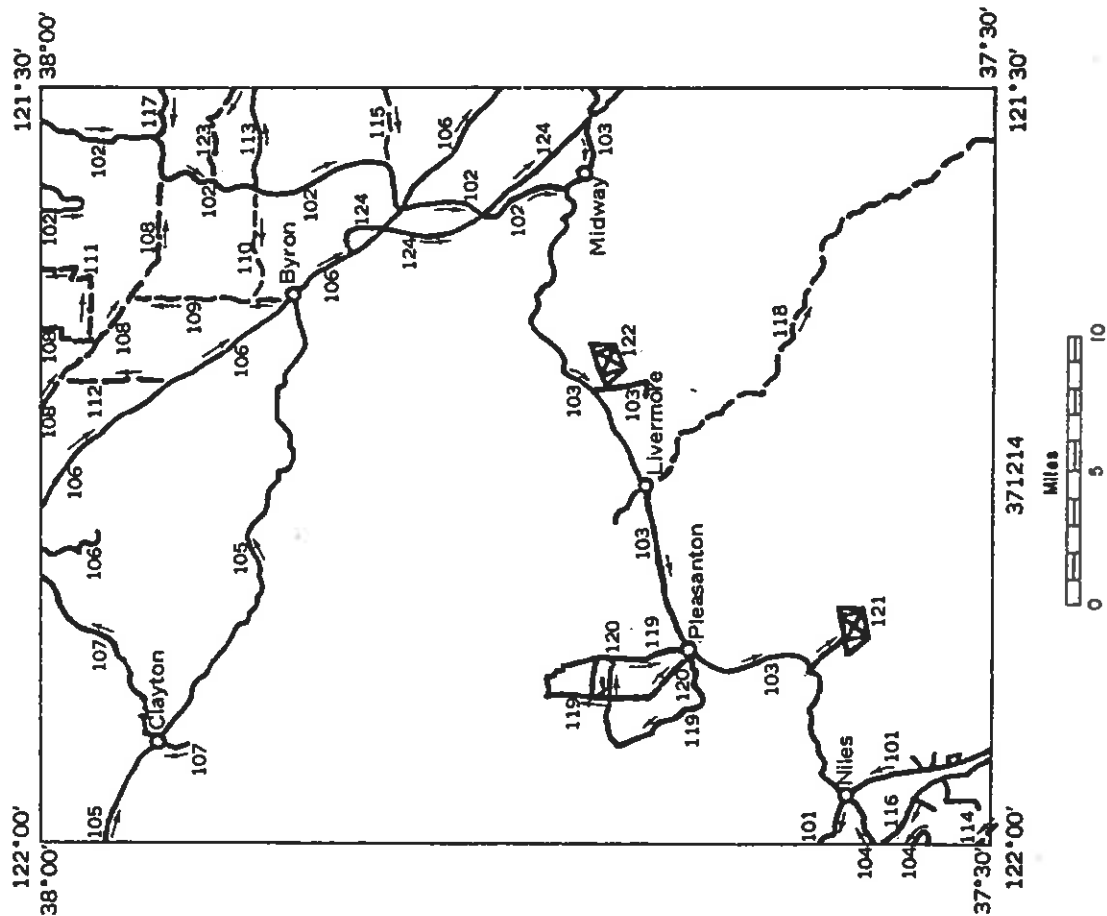
The following listings show the periodic adjustments of bench mark elevations as compiled by the U.S. Department of Commerce, Environmental Sciences Services Administration, Coast and Geodetic Survey for selected level lines through the study area. The adjustment periods range from 1912 to 1966.

APRIL 1975

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

VERTICAL CONTROL DATA by the NATIONAL GEODETIC SURVEY SEA LEVEL DATUM OF 1929

QUAD-----371214
CALIFORNIA 37°30' TO 38°00'
LATITUDE 121°30' TO 122°00'
LONGITUDE DIAGRAM SAN JOSE NJ 10-9



REPLACES EARLIER LIST

USCOWA-NOAA-ASHEVILLE

NOVEMBER 1966

U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
COAST AND GEODETIC SURVEY

VERTICAL CONTROL DATA

by the
Coast and Geodetic Survey
SEALEVEL DATUM OF 1929

QUAD 371214 PAGE NO. 4
CALIFORNIA
37° 30' to 38° 00'
LATITUDE
121° 30' to 122° 00'
LONGITUDE
DIAGRAM NJ 10-9 SAN JOSE

LINE 103 - - ADJUSTED ELEVATIONS

Bench Mark	1912 First- order (Feet)	1933 First- order (Feet)	1944-45 First- order (Feet)	1946-47 First- order (Feet)	1947 First- order (Feet)	1948 First- order (Feet)	1954 First- order (Feet)	1956 First- order (Feet)	1958 First- order (Feet)	1961 First- order (Feet)	1963 First- order (Feet)	1964 First- order (Feet)	Feb. 1965 First- order (Feet)	June 1965 First- order (Feet)
J 792				219.147					219.002	219.025		219.048		219.032
EFS 2														
H 792				261.827					261.732	261.748		261.784		261.774
G 792				299.921					299.921	299.908		299.934		299.934
EFS 1														
O 8 (USGS)	351.430			351.430					351.430	351.472		351.482		351.476
G 934									392.568	392.624		392.634		392.630
EFS 11														
J 934									398.917	398.979		398.972		398.982
N 792				453.759					453.759	453.828		453.828		453.828
NN 792									493.355	493.427		493.424		493.424
P 792									539.504	539.536		539.553		539.543
L 8	590.596			590.596					590.596	590.638		590.661		590.681
S 984														
Y 792									652.220	652.190				645.550
Z 792				692.892					692.892	692.948				692.991
K 8				719.211					719.211	719.260				719.293
J 8 (USGS)	719.211			739.792					739.785	739.802				739.874
EFS 12														
I 8	716.088			716.088					716.088	716.127				716.147
W 737									686.642	686.695				686.734
X 737									640.686	640.714				640.766
Y 737									596.039	596.104				596.163

SPUR LINE TO ATOMIC ENERGY COMMISSION LABORATORY (FORMERLY LIVERMORE NAVAL AIR STATION)

Z 737	601.016	601.009	601.029
113 (ALA CO.)		616.049	616.058
A 738	620.438	620.511	620.501
EFS 13		620.9	620.9
115 (ALA CO.)		675.533	675.517
B 738 RESET 1957		635.159	635.146
C 738		630.563	630.547
D 738		640.970	640.976
D 738 RESET 1960		640.979	640.976
TBM 33 V	638.821	638.785	638.768

END OF THE SPUR LINE

V 832	562.318	562.325	562.371
Z 927		551.876	551.902
EFS 14		553.5	
U 832 RESET 1957		550.419	550.370
N 832		536.738	536.616
F 832		533.542	533.486
EFS 15		532.4	
M 832		491.892	491.725
486.213 B (USOS)		486.046	485.875

NOVEMBER 1966

U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
COAST AND GEODETIC SURVEY

VERTICAL CONTROL DATA

by the
Coast and Geodetic Survey
SEA-LEVEL DATUM OF 1929

QUAD 371214 PAGE NO. 5

CALIFORNIA
LATITUDE 37°30' to 38°00'
LONGITUDE 121°30' to 122°00'
DIAGRAM NJ 10-9 SAN JOSE

LINE 103 (CONTINUED) - - ADJUSTED ELEVATIONS

Bench Mark	1912 First- order (Feet)	1933 First- order (Feet)	1944-45 First- order (Feet)	1946-47 First- order (Feet)	1947 First- order (Feet)	1948 First- order (Feet)	1954 First- order (Feet)	1956 First- order (Feet)	1958 First- order (Feet)	1960 First- order (Feet)	1961 First- order (Feet)	1964 First- order (Feet)	Feb. 1965 First- order (Feet)	June 1965 First- order (Feet)
Q 832					467.332			467.256	467.194	467.073				
Q 929					439.225			442.227	442.207	442.214				
S 832					447.624			439.208	439.172	439.179				
HIGH POINT								447.601	446.6	447.5				
T 832									447.542	447.450				
SPUR LINE TO LIVERMORE SKY RANCH AIRPORT														
E 8 RESET 1940					460.760			460.741	457.722	457.7				
E 8 RESET 1959								457.792	459.7	459.815				
EPS 104					457.283			457.256	457.210	457.171				
LIVERMORE E BASE RM 1					459.878			459.842	459.815	459.769				
LIVERMORE E BASE														
LIVERMORE E BASE RM 2					457.145			457.102	457.086	457.040				
LIVERMORE E BASE RM 3					436.594			436.541	436.528	465.918				
LIVERMORE E BASE AZI														
LIVERMORE E BASE RESET 1964														
END OF THE SPUR LINE														
K 832					414.710			414.674	414.661	414.589				
EPS 105									415.1	386.328				
J 832 RESET 1948					381.758			386.407	386.377	381.518				
J 832														
N 929														
LIVERMORE W BASE AZI					370.518			381.538	381.541					
LIVERMORE W BASE AZI								370.367	370.327					
LIVERMORE W BASE RESET 1961														
D 8					367.361			367.220	365.361	365.541				
LIVERMORE W BASE					359.632			359.425	367.168	367.083				
LIVERMORE W BASE RM 3									359.369	359.274				
LIVERMORE W BASE RM 2					360.012			359.770	359.711	361.679				
P 929					352.253			361.889	361.856	359.592				
H 832								352.201	352.197	361.777				
EPS 102									353.4	352.184				352.178
C 8					337.194			337.076	337.063					
Q 832					337.375			337.257	337.194	337.040				337.050
K 995										337.227				
P 832					332.962			332.719	332.621	332.608				337.542
B 8					302.637			302.637	302.637	302.637				302.637
EPS 103														
F 832					277.811			277.818	277.791	277.808				277.801
D 832					267.939			267.919	267.919	267.893				267.887
C 832					260.859			260.859	260.872	260.862				260.862
143 (USGS)					225.587			242.844	242.867	242.851				242.847
A 8					225.479				300.9					
B 832					204.813			225.587	225.603	225.590				225.590
E 148					204.813			218.143	218.156	218.146				218.146
A 832					192.214			204.813	204.816	204.806				204.806
								192.214	192.214	192.211				192.191

NOVEMBER 1966

U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
COAST AND GEODETIC SURVEY

VERTICAL CONTROL DATA

by the
Coast and Geodetic Survey
SEA-LEVEL DATUM OF 1929

QUAD 371214 PAGE NO. 6
CALIFORNIA 37°30' to 38°00'
LATITUDE 121°30' to 122°00'
LONGITUDE NJ 10-9 SAN JOSE
DIAGRAM

LINE 103 (CONTINUED) - - ADJUSTED ELEVATIONS

Bench Mark	1912 First- order (Feet)	1933 First- order (Feet)	1944-45 First- order (Feet)	1946-47 First- order (Feet)	1947 First- order (Feet)	1948 First- order (Feet)	1954 First- order (Feet)	1956 First- order (Feet)	1958 First- order (Feet)	1960 First- order (Feet)	1961 First- order (Feet)	1964 First- order (Feet)	Feb. 1965 First- order (Feet)	June 1965 First- order (Feet)	1966 First- order (Feet)
D 148		160.613		160.613	160.613	160.613	160.613	160.613	160.613	160.603			160.587		
BM 129.40 (SP.CO.)						125.804	125.794	125.777	125.777	125.735			125.722		
C 148		122.300					122.336	122.336	122.336	122.313			122.296		
Y 7	124.304	124.360				124.412	124.412	124.412	124.412	124.390			124.373		
J 878						141.214	141.214	141.214	141.214	141.181			141.122		
R 874						96.233	96.233	96.233	96.233	96.204			96.158		

LINE 104 - - ADJUSTED ELEVATIONS

Bench Mark	Spring 1934 First- order (Feet)	Fall 1934 First- order (Feet)	Spring 1935 First- order (Feet)	Spring 1936 Second- order (Feet)	1937 First- order (Feet)	1937-38 First- order (Feet)	1938-39 First- order (Feet)	1939-40 First- order (Feet)	Spring 1940 First- order (Feet)	1948 First- order (Feet)	1954 First- order (Feet)	1956 First- order (Feet)	1959 First- order (Feet)	1960 First- order (Feet)	1965 First- order (Feet)
N 888										39.019	37.493	37.415	37.470	37.375	37.303
M 877										37.605	37.513	37.434	37.480	37.375	37.306
M 888											38.635	38.573	38.625	38.524	38.445
N 877												38.9			
HIGH POINT															

LEVELING AT CENTER AIRPORT

END OF SPUR LINE

THE LINE LEAVES AND RE-ENTERS THE QUADRANGLE

W 946																
A 56 (C of F)													63.770			
Z 946													62.543			
A 44 (C of F)													57.169			
V 175													34.737			
EF 109													58.904			
37 (A. Co.)													60.8			
W 175													64.203			
E 592													64.183			
A 50 (C of F)													78.120			
V 946													69.839			
SWITCH RM 2													76.775			
SWITCH RM 1													84.203			
													84.695			
													84.137			

NOVEMBER 1966

U.S. DEPARTMENT OF COMMERCE
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COAST AND GEODETIC SURVEY

VERTICAL CONTROL DATA

by the
Coast and Geodetic Survey
SEA LEVEL DATUM OF 1929

QUAD 371214 PAGE NO. 13
CALIFORNIA
LATITUDE 37° 30' to 38° 00'
LONGITUDE 121° 30' to 122° 00'
DIAGRAM NJ 10-9 SAN JOSE

LINE 118 - - ADJUSTED ELEVATIONS

Bench Mark	1961 Second- order (Feet)
A 1123	519.572
TES MARI (ALA Co.)	552.295
EPS 54	552.6
118 (ALA Co.)	597.033
601 B (USGS)	601.246
163 (ALA Co.)	633.677
B 1123	688.542
165 (ALA Co.)	743.794
C 1123	761.517
EPS 55	761.9
784 B (USGS)	784.099
167 A (ALA Co.)	795.888
D 1123 (ALA Co.)	848.043
E 1123	849.080
EPS 56	849.6
F 1123	1074.663
G 1123	1411.890
H 1123	1523.291
172 (ALA Co.)	1623.878
54 (ALA Co.)	1731.735
J 1123	1885.485
174 (ALA Co.)	1878.320
K 1123	1986.768
175 (ALA Co.)	2042.224
L 1123	2060.508
L 1123 RESET 1964	2047.659
176 (ALA Co.)	2086.544
M 1123	2089.316
177 (ALA Co.)	2056.223
EPS 57	2056.5
N 1123	2074.185
178 (ALA Co.)	2145.878
P 1123 (ALA Co.)	2146.121
EPS 58	2146.7
178 A (ALA Co.)	2144.8
Q 1123	2180.448
179 (ALA Co.)	2239.218
R 1123	2276.590
180 (ALA Co.)	2285.921
S 1123	2315.684

LINE 119 - - ADJUSTED ELEVATIONS

Bench Mark	1964 First- order (Feet)	1965 First- order (Feet)
BERN PAIR (ALA Co.)	323.160	323.146
BM (ALA Co.)	323.841	323.854
J 972	357.227	357.243
H 972	420.839	420.859
134 (ALA Co.)	408.644	408.644
Q 972	365.708	365.705
GOLD CREEK AZI.	337.371	
GOLD CREEK AZI.		442.332
RESET 1964		386.974
F 972	386.964	
C	365.721	365.718
B	384.143	384.166
A	434.727	434.756
D	347.791	347.749
ALAMEDA COUNTY		336.262
P 22	338.566	338.520
P 22 N	338.569	338.543
SPUR TO MARKS WITHIN CAMP PARKS		
PFW 4	361.866	361.853
PFW 3	358.234	358.211
PFW 2	352.558	352.562
PFW 1	369.491	369.497
P 26	387.037	387.046
P 26 N	387.040	387.053
PFE 4	370.862	370.875
PFE 3	351.640	351.643
PFE 2	352.444	352.447
PFE 1	357.007	357.010
END OF SPUR LINE		
() P 12 N	357.145	357.152
() P 12 N	357.158	357.142
SPUR LINE TO BENCH MARK P 25		
() P 19 N	346.253	346.249
() P 19 N	346.248	346.246
PFS 3	346.558	346.561
PFS 4	343.113	343.113
() PFS 5	338.411	338.415
() PFS 6	334.383	334.353
PFS 1	338.575	338.552
PFS 2	343.604	343.607
P 25	344.343	344.335
P 25 N	344.346	344.255
END OF SPUR LINE		

NOVEMBER 1966

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by the
Coast and Geodetic Survey
SEA-LEVEL DATUM OF 1929

QUAD 371214 PAGE NO. 14
CALIFORNIA 37° 30' to 38° 00'
LATITUDE 121° 30' to 122° 00'
LONGITUDE NJ 10-9 SAN JOSE
DIAGRAM

LINE 119 (CONTINUED) - - ADJUSTED ELEVATIONS

Bench Mark	1964 First- order (Feet)	1965 First- order (Feet)
P 11	365.688	365.678
P 11 N	365.708	365.669
P 6	422.483	422.493
P 6 N	422.539	422.584
P 7	470.180	470.186
P 3	454.317	454.327
P 3 N	454.326	454.346
P 1	462.273	462.283
P 1 N	462.312	462.342
P 2	498.076	498.093
P 2 N	498.050	498.063
P 4	468.854	468.864
P 4 N	468.844	468.861
P 5	500.711	500.724
P 5 N	500.714	500.688
L P 8	473.099	473.106
P 8 N	473.119	473.132
L P 13	369.720	369.720
L ACC	387.204	387.204
L P 18	355.626	355.623
P 18 N	355.649	355.669
L P 9	413.887	413.894
P 9 N	413.861	413.831
L P 17	367.690	367.693
P 17 N	367.690	367.716
D 994		348.264
D 994 N		348.241
L P 24	350.898	350.895
P 24 N	350.915	350.872
A 981	343.533	343.526
A 981 N	343.546	343.520
B 981	337.112	337.096
B 981 N	337.122	337.092
C 981	338.700	338.703
C 981 N	338.677	338.664
SAN-CRI (C of F)		348.408

LINE 120 - - ADJUSTED ELEVATIONS

Bench Mark	1964 First- order (Feet)	1965 First- order (Feet)
A 972	345.055	345.042
G 981	328.595	328.582
G 981 N	328.589	328.546
B 972	328.110	328.090
C 972	332.844	332.814
HOFYARD (ALA Co.)		
F 981	333.881	333.838
F 981 N	329.921	329.885
E 981	329.944	329.881
E 981 N	324.927	324.875
E 981	324.950	324.809
D 972	324.684	324.602
D 981	324.684	324.602
D 981 N	327.713	327.713
E 972	331.472	331.443
L P 21		
B 994		330.678
B 994 N		330.744
L P 20		340.902
C 994		341.321
C 994 N		341.440

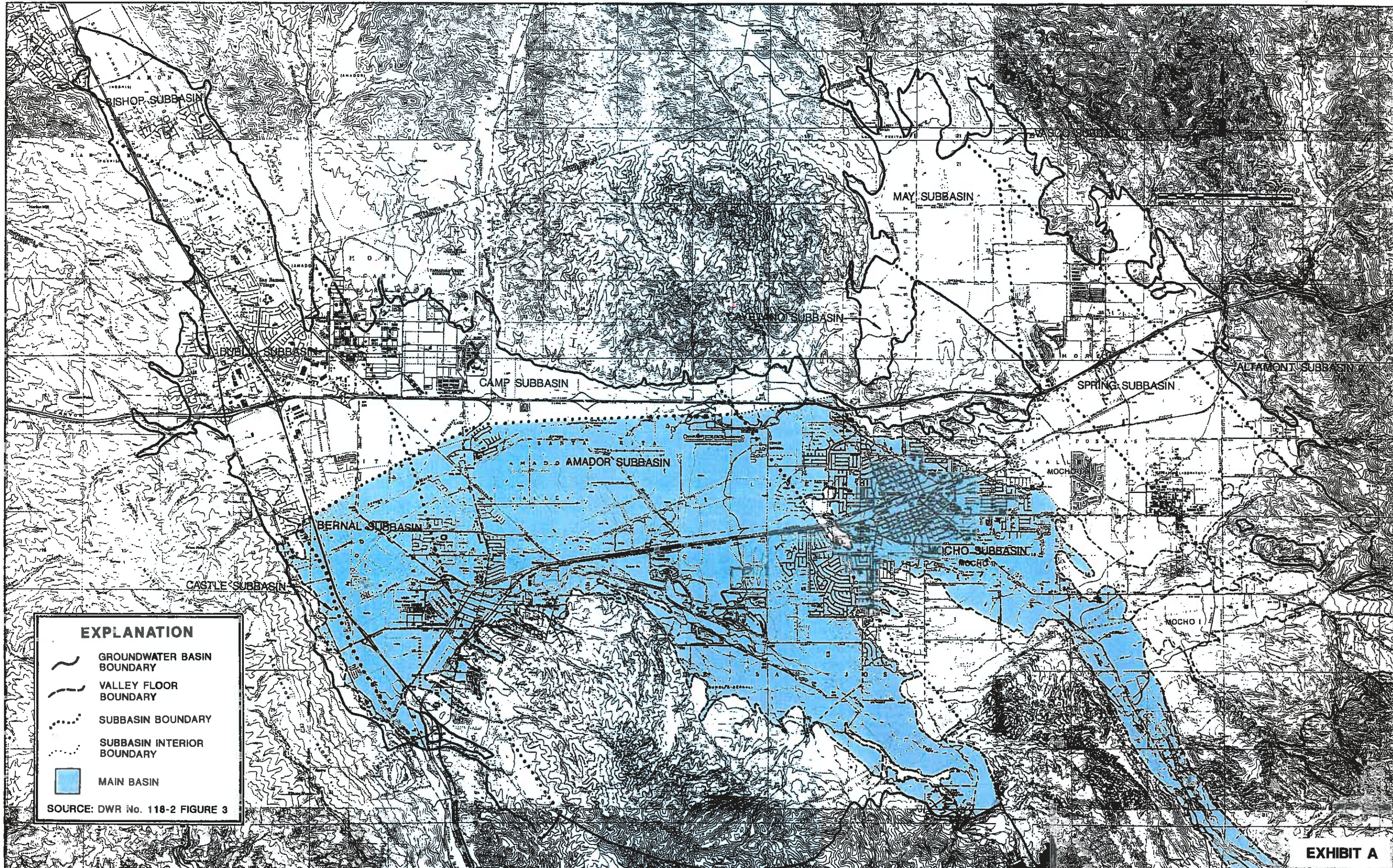
* LINE 121 - - ELEVATIONS

Bench Mark	1965 First-order (FEET)
VERAS D	76.025
VERAS C	249.425
VERAS E	253.494
VERAS B	259.507
VERAS F	79.098
VERAS P	139.747
VERAS A RM 2	134.750
VERAS A RM 1	144.767
VERAS A	145.010
VERAS A RM 1	144.955
VERAS A RM 2	474.956
VERAS A	475.754
VERAS A RM 1	475.567

* LINE 122 - - ELEVATIONS

Bench Mark	1965 First-order (FEET)
GREEN B	18.590
GREEN C RM 1	201.448
GREEN C RM 2	203.843
GREEN A RM 1	203.501
GREEN A RM 2	211.255
GREEN A RM 1	212.627
GREEN A RM 2	215.657
GREEN D	221.583
GREEN F RM 2	225.253
GREEN F RM 1	225.870
GREEN F	230.265
GREEN E	257.546
GREEN E	755.461
GREEN E	844.965

* These bench marks were not connected to the National Vertical Control network by precise leveling. They are based on an approximate vertical-angle elevation.



EXPLANATION

- GROUNDWATER BASIN BOUNDARY
- VALLEY FLOOR BOUNDARY
- SUBBASIN BOUNDARY
- SUBBASIN INTERIOR BOUNDARY
- MAIN BASIN

SOURCE: DWR No. 118-2 FIGURE 3

EXHIBIT A

REVISIONS	NUMBER	DESCRIPTION	BY	DATE	APPROVED
1					
2					
3					
4					
5					
6					
7					



ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	JAL
DESIGNED	
CHECKED	JAL
APPROVED	

WATER RESOURCES ENGINEERING

LIVERMORE VALLEY GROUNDWATER BASIN BOUNDARIES

SCALE	1"=6,000'	SHEET	GW
DATE	12 MAY 1994	OF	
FILE NO.	M-321	SHEETS	

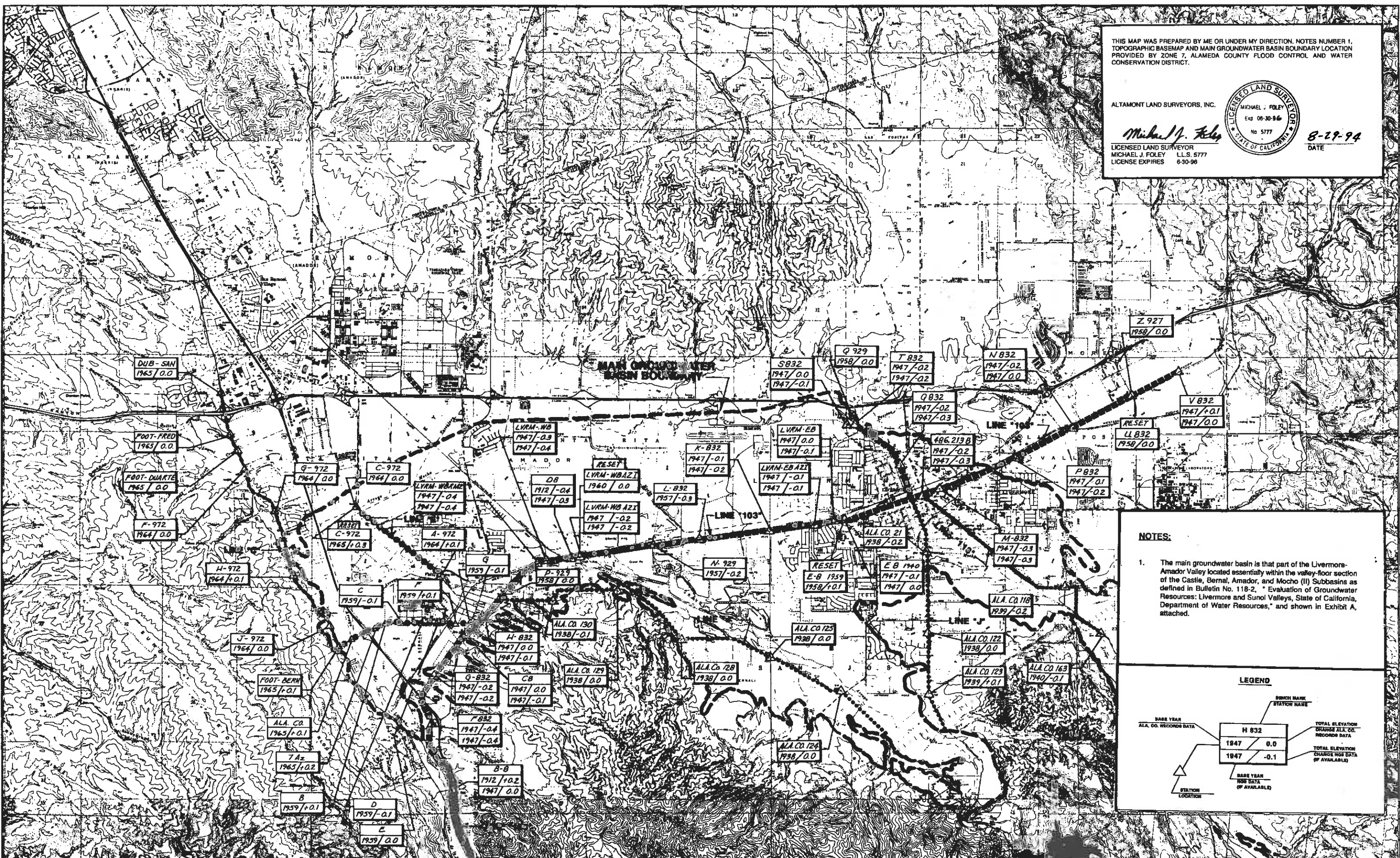
THIS MAP WAS PREPARED BY ME OR UNDER MY DIRECTION. NOTES NUMBER 1, TOPOGRAPHIC BASEMAP AND MAIN GROUNDWATER BASIN BOUNDARY LOCATION PROVIDED BY ZONE 7, ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT.

ALTAMONT LAND SURVEYORS, INC.

Michael J. Foley

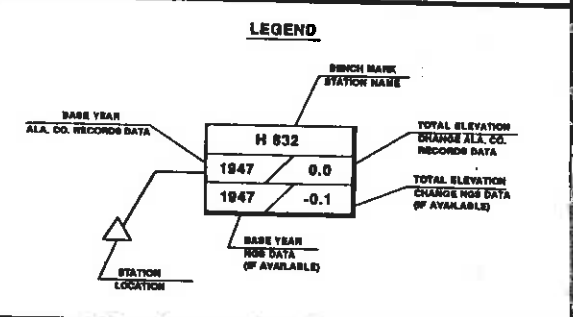
LICENSED LAND SURVEYOR
MICHAEL J. FOLEY L.L.S. 5777
LICENSE EXPIRES 6-30-96

8-29-94
DATE



NOTES:

1. The main groundwater basin is that part of the Livermore-Amador Valley located essentially within the valley-floor section of the Castle, Bernal, Amador, and Mocho (II) Subbasins as defined in Bulletin No. 118-2, "Evaluation of Groundwater Resources: Livermore and Sunol Valleys, State of California, Department of Water Resources," and shown in Exhibit A, attached.



REVISIONS

NO.	DESCRIPTION	BY	DATE	APPROVED

ZONE 7

ALAMEDA COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

**BENCH MARK STATION LOCATIONS
AND
LIVERMORE-AMADOR VALLEY MAIN GROUNDWATER BASIN**

SCALE 1" = 3000'

DATE NOVEMBER, 1993

FILE NO. WC 168

DRAWN JMF

DESIGNED M.J.F. ALTAMONT LAND SURVEYORS, INC.

CHECKED

APPROVED

1

OF 1 SHEETS