# A METHODOLOGY FOR ESTIMATING WATER YIELD OF SIERRA WATERSHEDS TRIBUTARY TO INDIAN WELLS VALLEY

**By**
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**Assisted by Tom Haslebacher**
**of The Kern County Water Agency**

**February, 2000**

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## Introduction

The purpose of this report is to develop a methodology for analysis of the water yield of Grapevine Canyon and other Sierra streams tributary to the Indian Wells Valley groundwater basin. Grapevine Canyon was chosen for analysis because it has a recording stream gage, and a rain gage has been maintained for a number of years.

The ultimate goal is the determination of the water yield of the Indian Wells Valley groundwater basin

This report was prepared for the Indian Wells Valley Water District.

## Description

Grapevine Canyon is one of many small watersheds facing eastward from the Sierra crest in eastern Kern County, California. It drains into Indian Wells Valley, where the towns of Ridgecrest and Inyokern are located. The U. S. Naval Weapons Center is located adjacent to Ridgecrest. A location map is shown on Figure 1.

## Approach

A recording stream gage was installed on Grapevine Creek in May, 1997, at the residence of Bert Koch, at approximately 3150 feet elevation. A topographic map of the watershed is shown on Figure 2. Also, a rain gage has been maintained at the location by Mr. Koch for a number of years. The study period of October, 1997 to September 1998 was selected because it included all of the Pacific winter storms, and allows the basin to drain off most of its surface water during the dry summer season.

The basic hydrologic relationship can be described mathematically as follows:

$$P_t - L = O_c + O_g + \Delta S$$

Where $P_t$ = total precipitation
$L$ = losses (evapotranspiration)
$O_c$ = channel outflow
$O_g$ = groundwater outflow
$\Delta S$ = change in storage

Another term, $P_n$, is used to indicate precipitation net of losses. All units are in acre-feet per year.

It is necessary to establish the elevation - precipitation relationship for the basin. There is only one hand-measured rain gage in Grapevine Canyon, i.e., the one at the Koch residence. There are also several telemetered gages in the region at higher elevations. Three stations in the vicinity were selected to represent the precipitation pattern for the study period. These were Grapevine (3150'), Indian Wells (4000') and Walker Pass (5570'). As a general rule, precip increases with elevation, but during the study period of 1997-98, the records indicate that precipitation decreased with elevation. The year 1997-98 was an El Nino year, with low-latitude Pacific storms. This probably accounts for the unusual orographic effects and precip patterns. Figure 3 shows the precipitation-elevation relationship for the period. Note that Bear Peak at 8223 feet, had only 6.23 inches of precip, whereas the gages close to Grapevine and lower in elevation had much higher amounts.

A graph (Figure 4) was prepared showing the rainfall and runoff at the Grapevine site during the study period. The precipitation scale is exaggerated to show the relationship between precip in inches and the runoff in acre-feet. Nearly half of the precip fell in February. Most of the runoff in May was snowmelt

The drainage area was divided into eight elevation intervals, generally every 1000 feet of elevation. An average basin elevation, weighted by area, was determined to be 5102 feet. Using the elevation-precipitation line shown on Figure 3, average precipitation for each elevation interval was determined. The weighted average precipitation and total precipitation falling on the basin are calculated in Table 1.

TABLE 1 TOTAL PRECIP AND AVERAGE BASIN PRECIP

| EL INTERVAL (1000') | AVE EL. (1000') | AREA (ACRES) | AVE PRECIP (IN) | AVE PRECIP (FT) | AF | AVE P*A |
|---|---|---|---|---|---|---|
| 8-8.45 | 8.23 | 31 | 9.47 | 0.79 | 25 | 297 |
| 7-8 | 7.5 | 578 | 10.22 | 0.85 | 492 | 5909 |
| 7-7.8 | 7.4 | 69 | 10.33 | 0.86 | 59 | 714 |
| 6-7 | 6.5 | 858 | 11.26 | 0.94 | 805 | 9656 |
| 5-6 | 5.5 | 1005 | 12.29 | 1.02 | 1029 | 12352 |
| 5-5.2 | 5.1 | 18 | 12.71 | 1.06 | 19 | 228 |
| 4-5 | 4.5 | 2426 | 13.33 | 1.11 | 2694 | 32328 |
| 3.15-4 | 3.58 | 1171 | 14.28 | 1.19 | 1394 | 16724 |
| TOTALS | | 6156 | | | 6,517 | 78,207 |
| AVE P = | 12.71 | INCHES | | | | |

Losses due to evaporation and plant transpiration were estimated from information in the booklet entitled "The Climate of Kern County", prepared by the National Weather Service and published by the Kern County Board of Trade. A description of potential evapotranspiration (PET) is given in part as follows: "...the amount of moisture that would be lost to the soil by evaporation and transpiration under existing conditions of temperature and with an adequate supply of moisture available". Pan evaporation, a standard measure of evaporation at weather stations, is also described. Pan evaporation is directly related to PET, therefore a monthly distribution of PET can be obtained as a proportion of monthly pan evaporation. The China Lake Naval Weapons Center maintains a record of pan evaporation, and the monthly distribution was applied to obtain PET for the Grapevine Canyon study. Note that PET varies with the season, and decreases with elevation. Inyokern, at an elevation of 2440 feet, has an annual PET of 37.9 inches. Randsburg, at an elevation of 3530 feet, has a PET of 36.6 inches. The Climate of Kern County also contains a contour map of annual PET, which shows a value of about 30 inches at the west (high) end of Grapevine Canyon.

Only precipitation which exceeds potential evapotranspiration in a given month is available for water yield for the Indian Wells Valley groundwater basin, Precipitation which does not exceed the potential evapotranspiration becomes evaporation loss (ET). Figure 5 shows the monthly precipitation as bars and the PET as a curve at the Grapevine gaging site. Tables 2a and 2b show the calculation of net precip by elevation interval. Note that an adjustment must be made for the fact that in December, January and February, some of the precipitation fell as snow and was retained in the snowpack until May, when it then melted and ran off. Because the runoff occurred in May when losses were much higher, the result was to reduce the effective yield of the basin. Figure 6 shows the snowmelt runoff

## TABLE 2a NET PRECIPITATION

| | |
|---|---|
| TOTAL NET PRECIP = | 3432 |
| SNOWMELT ADJ. = | -362 |
| ADJ. TOTAL NET PRECIP = | 3070 |

EFFECT OF SNOWMELT ON NET PRECIP

EL INTERVAL = 8.23
ACRES = 31

| | PRECIP DIST | PET %DIST | PRECIP | PET | NET PRECIP | SNOW SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.01 | 2.40 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 0.80 | 0.84 | 0.00 | 0.80 | 0.00 | 0.00 | 0.00 |
| DEC | 0.15 | 2.21 | 1.47 | 0.69 | 0.78 | 0.04 | 0.00 | 0.00 | 0.00 |
| JAN | 0.04 | 1.73 | 0.42 | 0.54 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 4.45 | 0.54 | 3.90 | 0.13 | 0.00 | 0.00 | 0.00 |
| MAR | 0.04 | 4.69 | 0.34 | 1.45 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.17 | 2.66 | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 0.80 | 3.26 | 0.00 | [illegible] | 3.68 | 0.42 | 3.26 |
| JUN | 0.02 | 16.10 | 0.14 | 4.99 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.09 | 5.50 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.28 | 4.96 | 0.00 | 0.28 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.49 | 3.15 | 0.00 | 0.49 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 9.47 | 31.0 | 4.68 | 9.47 | 3.68 | 0.42 | 3.26 |
| | | AF = | 27 | | 12 | 25 | 10 | 1 | 9 |
| | | | | | | | CUM. SNOW = | | 9 |

D-J-F RAIN FACTOR = 0.03
SNOWSHIFT AD. -3 AF
CUM. SNOWSHIFT ADJ = -3 AF

EL INTERVAL = 7.5
ACRES = 578

| | PRECIP DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.01 | 2.47 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 0.87 | 0.87 | 0.00 | 0.87 | 0.00 | 0.00 | 0.00 |
| DEC | 0.15 | 2.21 | 1.58 | 0.70 | 0.88 | 0.10 | 0.00 | 0.00 | 0.00 |
| JAN | 0.04 | 1.73 | 0.46 | 0.55 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 4.80 | 0.56 | 4.24 | 0.29 | 0.00 | 0.00 | 0.00 |
| MAR | 0.04 | 4.69 | 0.36 | 1.49 | 0.00 | 0.36 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.51 | 0.18 | 2.73 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 0.86 | 3.36 | 0.00 | 7.30 | 3.94 | 0.47 | 3.47 |
| JUN | 0.02 | 16.10 | 0.16 | 5.13 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.10 | 5.66 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.30 | 5.10 | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.53 | 3.24 | 0.00 | 0.53 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 10.22 | 31.9 | 5.12 | 10.22 | 3.94 | 0.47 | 3.47 |
| | | AF = | 492 | | 247 | 492 | 190 | 22 | 167 |
| | | | | | | | CUM. AF SNOW | | 176 |

D-J-F RAIN FACTOR = 0.06
EL. INTERVAL SNOWSHIFT ADJ : -57 AF
CUM. SNOWSHIFT ADJ = -60

EL INTERVAL = 7.4
ACRES : 69

| | PRECIP % DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.01 | 2.48 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 0.88 | 0.87 | 0.00 | 0.88 | 0.00 | 0.00 | 0.00 |
| DEC | 0.15 | 2.21 | 1.60 | 0.71 | 0.89 | 0.11 | 0.00 | 0.00 | 0.00 |
| JAN | 0.04 | 1.73 | 0.46 | 0.55 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 4.85 | 0.56 | 4.29 | 0.34 | 0.00 | 0.00 | 0.00 |
| MAR | 0.04 | 4.69 | 0.37 | 1.50 | 0.00 | 0.37 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.18 | 2.74 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 0.87 | 3.37 | 0.00 | [illegible] | 3.93 | 0.47 | 3.46 |
| JUN | 0.02 | 16.10 | 0.16 | 5.15 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.10 | 5.68 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.31 | 5.12 | 0.00 | 0.31 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.54 | 3.25 | 0.00 | 0.54 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 10.33 | 32.0 | 5.19 | 10.33 | 3.94 | 0.47 | 3.46 |
| | | AF = | 59 | | 30 | 59 | 23 | 3 | 20 |
| | | | | | | | CUM. AF SNOW | | 196 |

D-J-F RAIN FACTOR = 0.07
SNOWSHIFT AD. -7 AF
CUM. SNOWSHIFT ADJ = -67 AF

EL INTERVAL = 6.5
ACRES : 858

| | PRECIP DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.01 | 2.56 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 0.96 | 0.90 | 0.05 | 0.96 | 0.05 | 0.05 | 0.00 |
| DEC | 0.15 | 2.21 | 1.74 | 0.73 | 1.01 | 0.16 | 0.00 | 0.00 | 0.00 |
| JAN | 0.04 | 1.73 | 0.50 | 0.57 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 5.29 | 0.58 | 4.71 | 0.48 | 0.00 | 0.00 | 0.00 |
| MAR | 0.04 | 4.69 | 0.40 | 1.55 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.20 | 2.83 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 0.95 | 3.48 | 0.00 | 7.81 | 4.33 | 0.53 | 3.80 |
| JUN | 0.02 | 16.10 | 0.17 | 5.32 | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.11 | 5.87 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.33 | 5.29 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.59 | 3.36 | 0.00 | 0.59 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 11.26 | 33.1 | 5.77 | 11.26 | 4.38 | 0.58 | 3.80 |
| | | AF = | 805 | | 413 | 805 | 313 | 42 | 272 |
| | | | | | | | CUM. AF SNOW | | 467 |

D-J-F RAIN FACTOR = 0.09
SNOWSHIFT AD. -100 AF
CUM. SNOWSHIFT ADJ = -166 AF

# TABLE 2b NET PRECIPITATION

EL INTERVAL = 5.5
ACRES : 1085

| | PRECIP DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.02 | 2.65 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 1.04 | 0.93 | 0.11 | 1.04 | 0.11 | 0.11 | 0.00 |
| DEC | 0.15 | 2.21 | 1.90 | 0.76 | 1.15 | 1.10 | 0.35 | 0.35 | 0.00 |
| JAN | 0.04 | 1.73 | 0.55 | 0.59 | 0.00 | 0.32 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 5.77 | 0.60 | 5.17 | 3.35 | 2.75 | 2.75 | 0.00 |
| MAR | 0.04 | 4.69 | 0.44 | 1.61 | 0.00 | 0.44 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.22 | 2.94 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 1.04 | 3.61 | 0.00 | 1.50 | 0.89 | 0.21 | 0.68 |
| JUN | 0.02 | 16.10 | 0.19 | 5.52 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.12 | 6.08 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.36 | 5.48 | 0.00 | 0.36 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.64 | 3.48 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 12.29 | 34.3 | 6.43 | 12.29 | 4.09 | 3.41 | 0.68 |
| | | AF = | 1030 | | 538 | 1030 | 343 | 285 | 57 |
| | | | | | | | CUM. AF SNOW | | 525 |

D-J-F RAIN FACTOR = 0.58
SNOWSHIFT AD -196 AF
CUM. SNOWSHIFT ADJ = -362 AF

EL INTERVAL = 5.1
ACRES : 18

| | PRECIP %DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.02 | 2.69 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 1.08 | 0.95 | 0.13 | 1.08 | 0.13 | 0.13 | 0.00 |
| DEC | 0.15 | 2.21 | 1.97 | 0.77 | 1.20 | 1.97 | 1.20 | 1.20 | 0.00 |
| JAN | 0.04 | 1.73 | 0.57 | 0.60 | 0.00 | 0.57 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 5.97 | 0.61 | 5.36 | 5.97 | 5.36 | 5.36 | 0.00 |
| MAR | 0.04 | 4.69 | 0.45 | 1.63 | 0.00 | 0.45 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.22 | 2.98 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 1.07 | 3.66 | 0.00 | 1.07 | 0.00 | 0.00 | 0.00 |
| JUN | 0.02 | 16.10 | 0.19 | 5.59 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.12 | 6.17 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.38 | 5.56 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.66 | 3.53 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 12.71 | 34.7 | 6.69 | 12.71 | 6.69 | 6.69 | 0.00 |
| | | AF = | 19 | | 10 | 19 | 10 | 10 | 0 |
| | | | | | | | CUM. AF SNOW | | 525 |

D-J-F RAIN FACTOR = 1.00
SNOWSHIFT AD 0 AF
CUM. SNOWSHIFT ADJ = -362 AF

EL INTERVAL = 4.5
ACRES : 2426

| | PRECIP DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.02 | 2.75 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 1.13 | 0.97 | 0.16 | 1.13 | 0.16 | 0.16 | 0.00 |
| DEC | 0.15 | 2.21 | 2.06 | 0.78 | 1.28 | 2.06 | 1.28 | 1.28 | 0.00 |
| JAN | 0.04 | 1.73 | 0.59 | 0.61 | 0.00 | 0.59 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 6.26 | 0.62 | 5.64 | 6.26 | 5.64 | 5.64 | 0.00 |
| MAR | 0.04 | 4.69 | 0.47 | 1.66 | 0.00 | 0.47 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.24 | 3.04 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 1.13 | 3.73 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 |
| JUN | 0.02 | 16.10 | 0.20 | 5.71 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.13 | 6.29 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.40 | 5.67 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.70 | 3.61 | 0.00 | 0.70 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 13.33 | 35.4 | 7.08 | 13.33 | 7.08 | 7.08 | 0.00 |
| | | AF = | 2694 | | 1432 | 2694 | 1432 | 1432 | 0 |
| | | | | | | | CUM. AF SNOW | | 525 |

D-J-F RAIN FACTOR = 1.00
SNOWSHIFT AD 0 AF
CUM. SNOWSHIFT ADJ = -362 AF

EL INTERVAL = 3.58
ACRES : 1171

| | PRECIP DIST | PET %DIST | PRECIP | PET | UNADJ. NET PRECIP | SNOW MELT SHIFT | ADJ. NET PRECIP | RAIN NET P | SNOW NET P |
|---|---|---|---|---|---|---|---|---|---|
| OCT | 0.00 | 7.75 | 0.02 | 2.83 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| NOV | 0.08 | 2.73 | 1.21 | 1.00 | 0.22 | 1.21 | 0.22 | 0.22 | 0.00 |
| DEC | 0.15 | 2.21 | 2.21 | 0.81 | 1.40 | 2.21 | 1.40 | 1.40 | 0.00 |
| JAN | 0.04 | 1.73 | 0.64 | 0.63 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 |
| FEB | 0.47 | 1.76 | 6.71 | 0.64 | 6.07 | 6.71 | 6.07 | 6.07 | 0.00 |
| MAR | 0.04 | 4.69 | 0.51 | 1.71 | 0.00 | 0.51 | 0.00 | 0.00 | 0.00 |
| APR | 0.02 | 8.57 | 0.25 | 3.13 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 |
| MAY | 0.08 | 10.53 | 1.21 | 3.85 | 0.00 | 1.21 | 0.00 | 0.00 | 0.00 |
| JUN | 0.02 | 16.10 | 0.22 | 5.88 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 |
| JUL | 0.01 | 17.75 | 0.14 | 6.49 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| AUG | 0.03 | 16.00 | 0.42 | 5.85 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 |
| SEP | 0.05 | 10.17 | 0.75 | 3.72 | 0.00 | 0.75 | 0.00 | 0.00 | 0.00 |
| TOTALS | 1.00 | 100 | 14.28 | 36.5 | 7.69 | 14.28 | 7.69 | 7.69 | 0.00 |
| | | AF = | 1393 | | 750 | 1393 | 750 | 750 | 0 |
| | | | | | | | CUM. AF SNOW | | 525 |

D-J-F RAIN FACTOR = 1.00
SNOWSHIFT AD 0 AF
CUM. SNOWSHIFT ADJ = -362 AF

in May, 1998.

Grapevine Canyon has a small but significant groundwater basin. Figure 7 shows a schematic channel cross-section of Grapevine Creek at the gaging site. There are three basic conditions which can exist at the gaging cross-section. Line A-A' (dotted) was the case during the rainy period, in which the stream fed into the groundwater. This is known as the "influent" condition. Line B-B' shows an "effluent" condition, in which there is leakage from the groundwater back into the channel. This is the typical situation following the rainy period, and was the condition at the beginning and the end of the 1997-98 study period. Some of the water that was stored in groundwater during the rainy period was carried over into 1998-99. Line C-C' is a drought condition, in which the stream has dried up and the groundwater level is below the channel bottom.

The groundwater basin is evidenced by the Cottonwood trees and the well located on the Koch property. The year 1997-98 was a very wet water year, and some of the water that fell on the watershed was stored in the groundwater basin. This resulted in a positive change in storage ($\Delta S$), which will be evacuated by groundwater outflow in succeeding dry or normal years.

Groundwater outflow is calculated by means of the formula $O_g = PIA$, in which "$O_g$" is the flow in cubic feet per day, "P" is the unit flow in cubic feet per day per square foot of cross-section. This factor ranges from about 30 to 670, for sand and gravel, depending upon the transmissibility of the alluvium. . "I" is the slope of the groundwater surface, and can be assumed to be equal to the slope of the channel bottom (.052). "A" is the cross-sectional area of the groundwater flow. At this time, A cannot be determined. Flow can, of course, be expressed in acre-feet per year.

## Conclusions and Recommendations

A flow chart depicting the methodology is shown on Figure 8. Installation of another hand-measured rain gage at a higher elevation in the watershed would help the precipitation reliability. Surface channel outflow was measured by the stream gage. Groundwater outflow can be determined when dimensions of the alluvial cross-section are known. This should be determined by geophysical methods such as drilling of additional shallow wells and/or seismic measurements. Study of the alluvial material will improve the estimate of transmissibility. Measurement of the well at the Koch property should be made on a regular basis, because it is related to the groundwater outflow. It may be necessary to adjust the PET loss curves or precip line to calibrate the methodology. Because it is a residual, the change in storage ($\Delta S$) may also include errors in precipitation or losses.

Analyses of future years should be made to better define the basin yield characteristics. Eventually, a long-term basin yield can be estimated. The year 1998-99 was a dry year, with different conditions. Some of the water stored in 1997-98 probably drained out in 1998-99, resulting in a year of negative $\Delta S$.

Table 3 shows the study results. Note the column at the right of the table, which shows subjective confidence levels of the data used n the study.

## TABLE 3 STUDY RESULTS

| | | | SUBJECTIVE CONFIDENCE RATING |
|---|---|---|---|
| STUDY PERIOD | OCT 1997-SEP 1998 | | |
| AREA | 9.61 | $MI^2$ | 100 |
| AVE ELEVATION | 5100 | FEET | 100 |
| AVE PRECIPITATION | 12.7 | INCHES | 60 |
| TOTAL PRECIPITATION ($P_t$) | 6,510 | ACRE-FEET | |
| -LOSSES (L) | 3,440 | ACRE-FEET | 60 |
| =NET PRECIPITATION ($P_n$) | 3,070 | ACRE-FEET | |
| -CHANNEL OUTFLOW ($O_c$) | 2,150 | ACRE-FEET | 100 |
| - GROUNDWATER OUTFLOW ($O_g$) | (UNKNOWN) | ACRE-FEET | 0 |
| = CHANGE IN STORAGE ($\Delta S$) | (UNKNOWN) | ACRE-FEET | 0 |
| | | | |
| NET AF/$MI^2$ YIELD | 320 1) | ACRE-FEET/ $MI^2$ | |

1) Net precipitation divided by the drainage area.

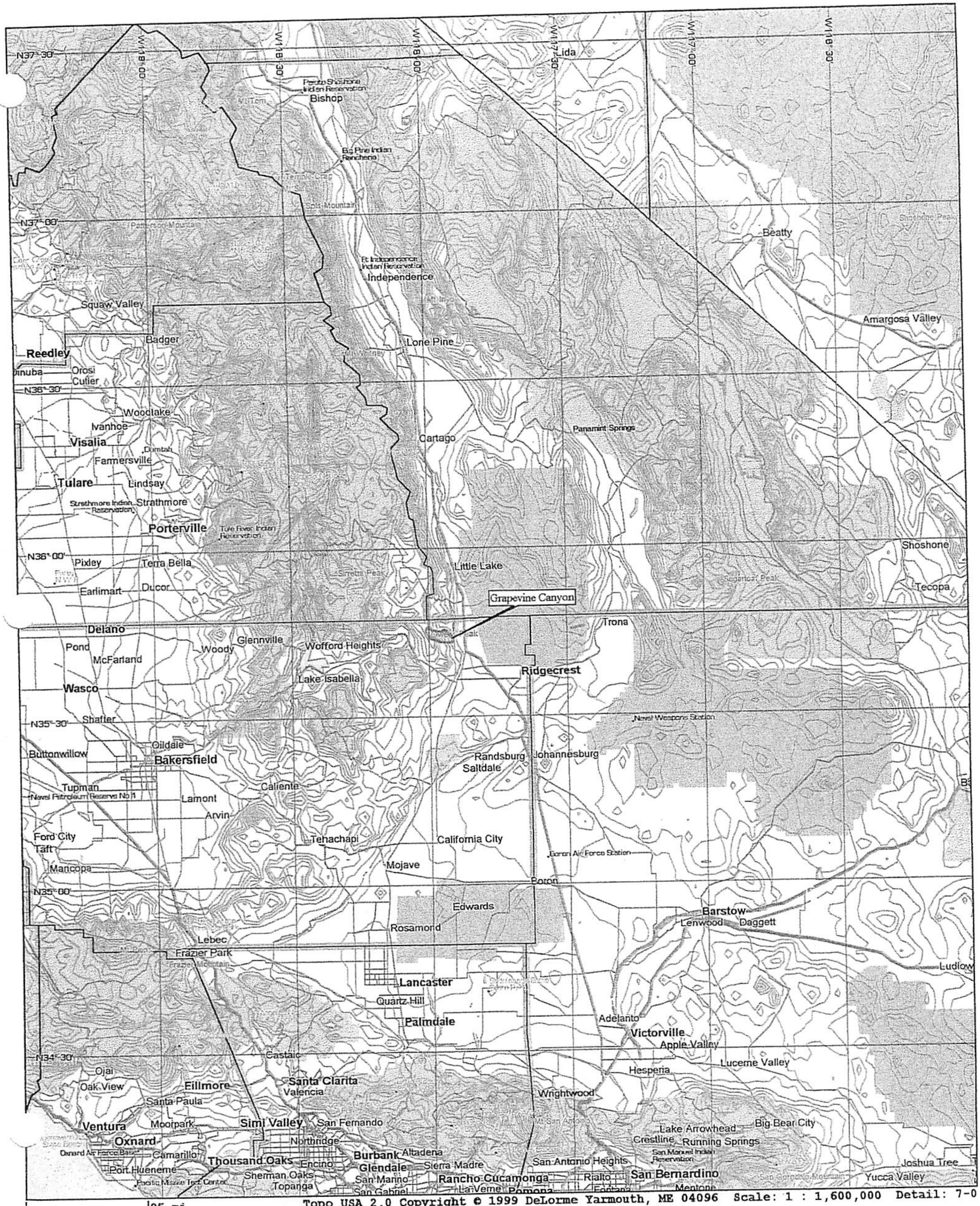

N37°30'
W118°00'
W118°30'
W118°00'
W117°30'
W117°00'
W116°30'
Lida
Bishop
N37°00'
Beatty
Independence
Squaw Valley
Amargosa Valley
Badger
Lone Pine
Reedley
Orosi
Cutler
N36°30'
Woodlake
Ivanhoe
Visalia
Cartago
Panamint Springs
Farmersville
Tulare
Lindsay
Strathmore
Porterville
Shoshone
N36°00'
Pixley
Terra Bella
Little Lake
Earlimart
Ducor
Tecopa
Grapevine Canyon
Delano
Trona
Pond
Glennville
Woody
Wofford Heights
McFarland
Ridgecrest
Lake Isabella
Wasco
N35°30'
Shafter
Naval Weapons Station
Oildale
Buttonwillow
Bakersfield
Randsburg
Johannesburg
Saltdale
Tupman
Caliente
Lamont
Arvin
Ford City
Taft
Tehachapi
California City
Maricopa
Mojave
Boron
N35°00'
Edwards
Barstow
Lenwood
Daggett
Rosamond
Lebec
Frazier Park
Ludlow
Lancaster
Quartz Hill
Palmdale
Adelanto
Victorville
Apple Valley
N34°30'
Castaic
Lucerne Valley
Hesperia
Ojai
Santa Clarita
Oak View
Fillmore
Valencia
Wrightwood
Santa Paula
Ventura
Moorpark
Simi Valley
San Fernando
Lake Arrowhead
Big Bear City
Oxnard
Northridge
Crestline
Running Springs
Camarillo
Thousand Oaks
Burbank
Altadena
Port Hueneme
Encino
Glendale
Sierra Madre
San Antonio Heights
Joshua Tree
Sherman Oaks
San Marino
Rancho Cucamonga
Rialto
San Bernardino
Yucca Valley
Topanga
La Verne
Pomona
25 mi
Topo USA 2.0 Copyright © 1999 DeLorme Yarmouth, ME 04096 Scale: 1 : 1,600,000 Detail: 7-0

**Figure 1**

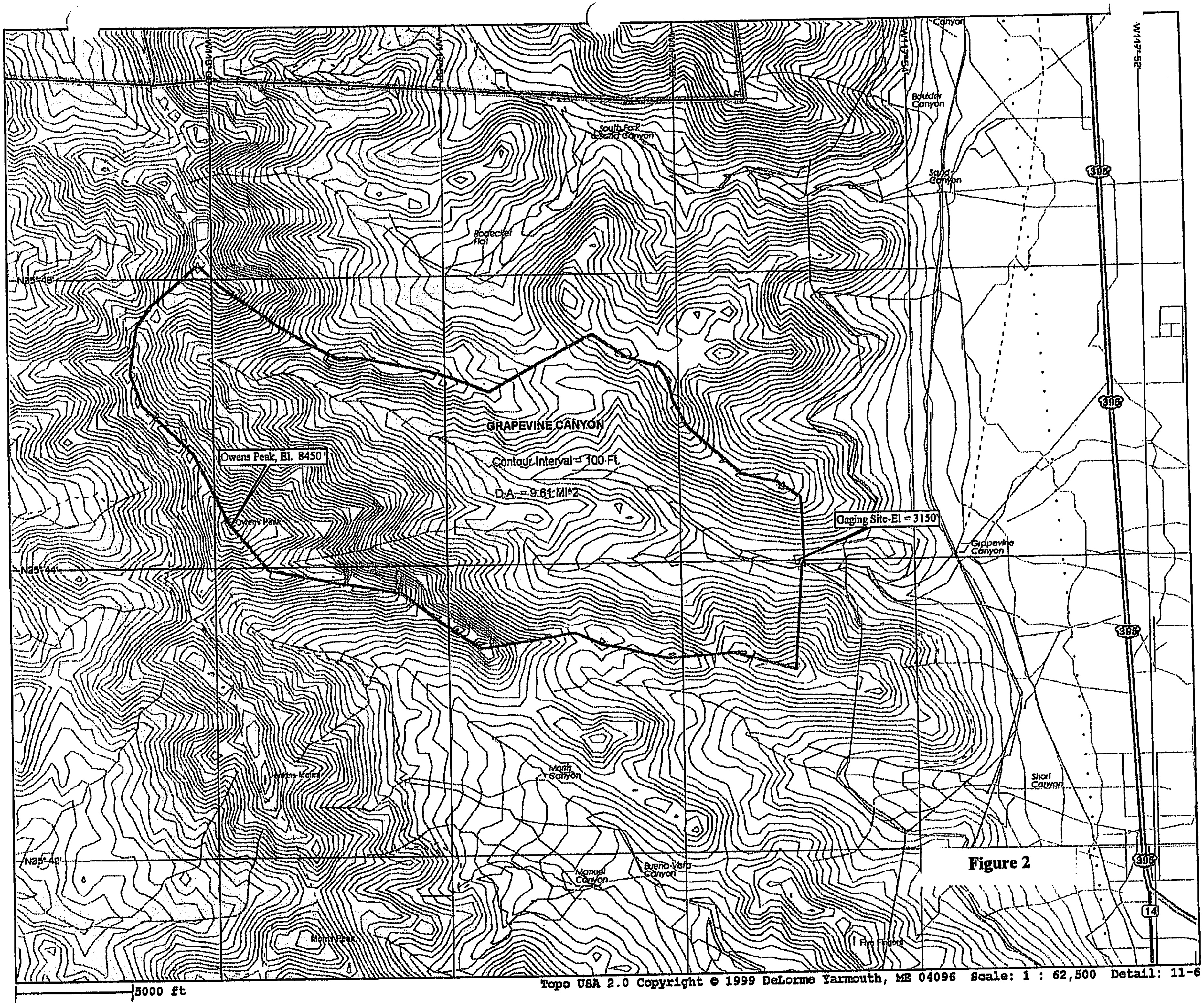



Figure 2

Topo USA 2.0 Copyright © 1999 DeLorme Yarmouth, ME 04096 Scale: 1 : 62,500 Detail: 11-6

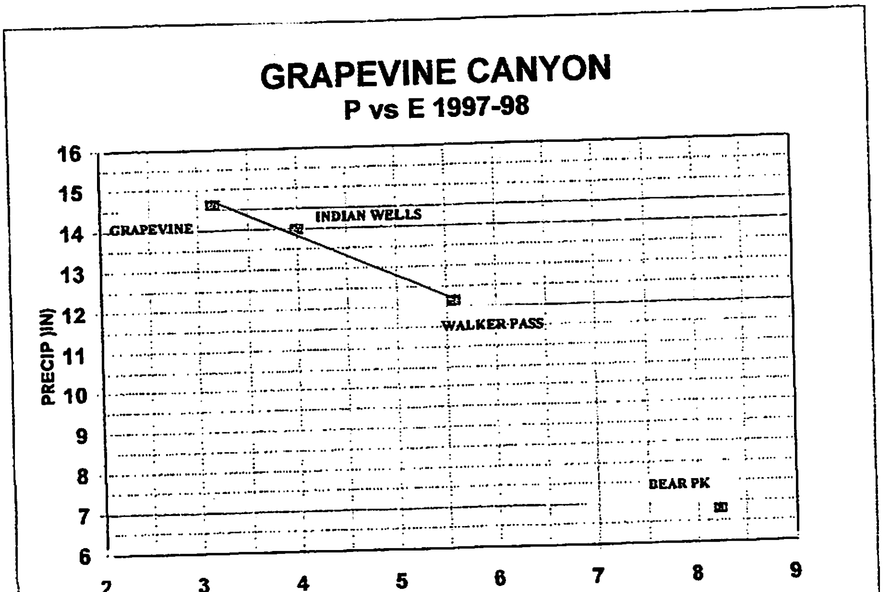



FIGURE 3

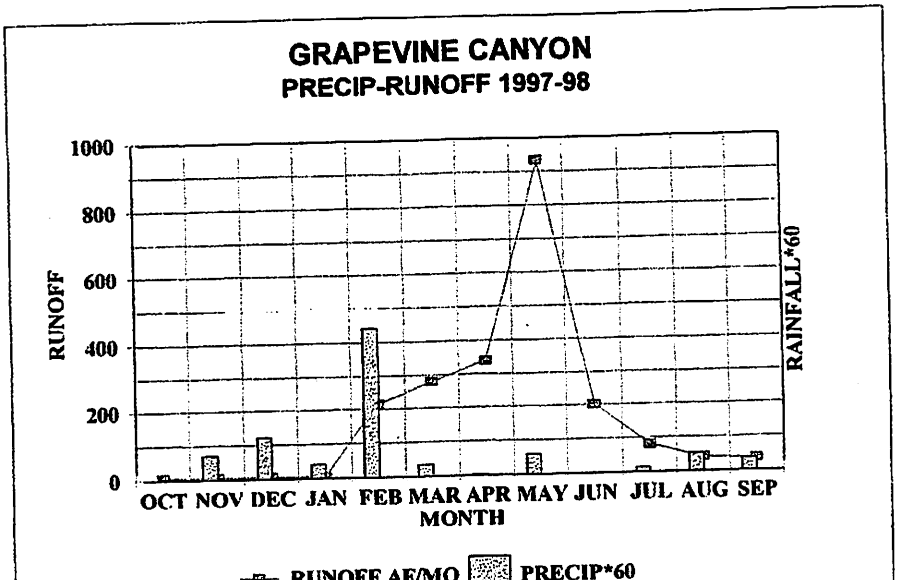
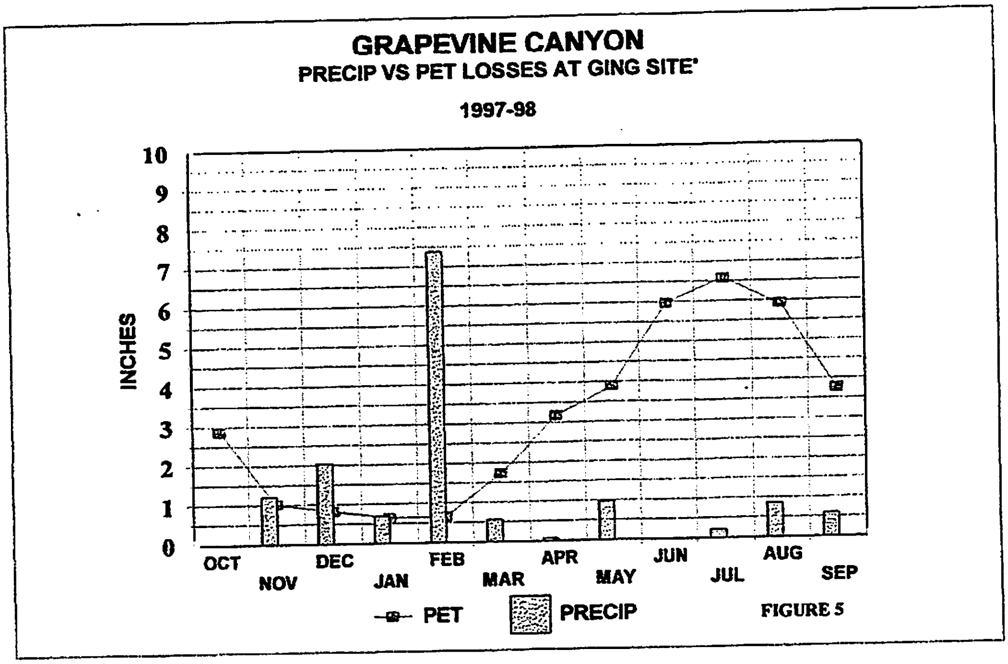
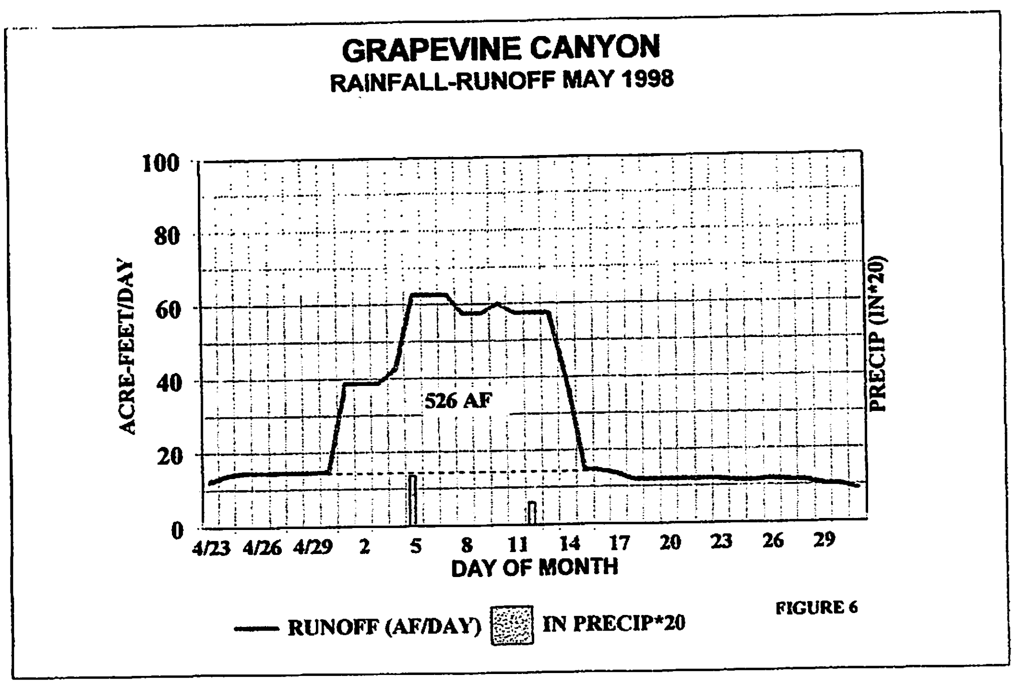



FIGURE 4


GRAPEVINE CANYON
PRECIP VS PET LOSSES AT GING SITE'
1997-98
INCHES
0
1
2
3
4
5
6
7
8
9
10
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
PET
PRECIP
FIGURE 5


GRAPEVINE CANYON
RAINFALL-RUNOFF MAY 1998
ACRE-FEET/DAY
PRECIP (IN*20)
0
20
40
60
80
100
526 AF
4/23
4/26
4/29
2
5
8
11
14
17
20
23
26
29
DAY OF MONTH
RUNOFF (AF/DAY)
IN PRECIP*20
FIGURE 6

# GRAPEVINE CREEK

## CHANNEL CROSS-SECTION
## AT GAGING SITE

LOOKING EAST

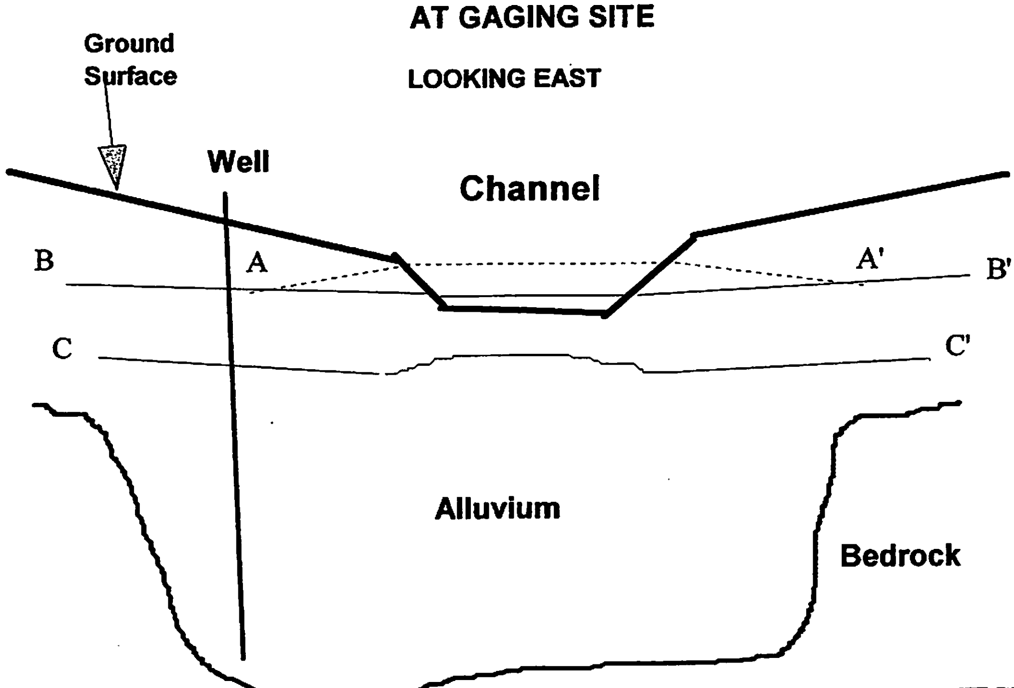
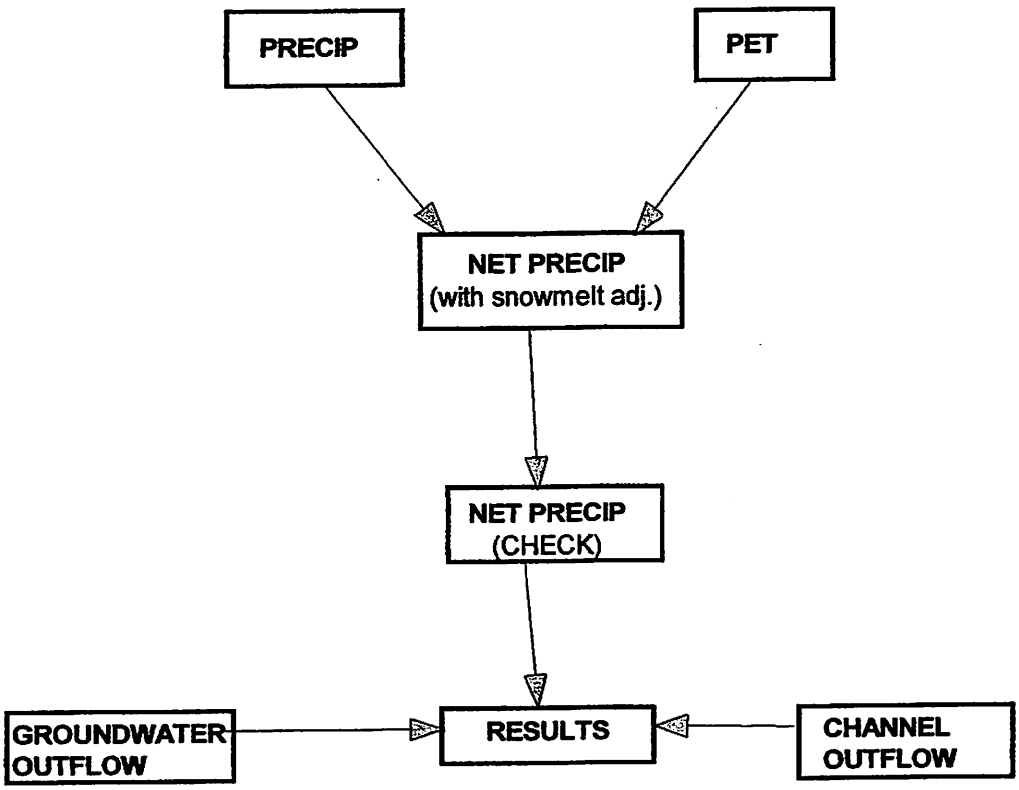



FIGURE 7

## METHODOLOGY FLOWCHART




**The basic hydrologic relationship can be described mathematically as follows:**

$$Pt - L = Oc + Og + S$$

**Where**

**Pt = total precipitation**
**L = losses (evapotranspiration)**
**Oc = channel outflow**
**Og = groundwater outflow**
**S = change in storage (can be negative or positive)**

**FIGURE 8**