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# ENGINEERING CONSIDERATIONS OF GROUNDWATER YIELDS AND RIGHTS ON THE NIPOMO MESA SUB-AREA SAN LUIS OBISPO COUNTY, CALIFORNIA

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LAWRANCE, FISK & McFARLAND, INC.

CONSULTING CIVIL & ENVIRONMENTAL ENGINEERS

928 GARDEN STREET, SUITE 1 -- SANTA BARBARA CA. 93101

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## ENGINEERING CONSIDERATIONS OF GROUNDWATER YIELDS AND RIGHTS ON THE NIPOMO MESA SUB-AREA, SAN LUIS OBISPO COUNTY

### I - INTRODUCTION

Nipomo Community Services District (NCSD) provides various community services, including water supply and sewerage, to much of the urban area of the Nipomo Mesa, including the Town of Nipomo. NCSD's water supply is derived solely from groundwater on the Nipomo Mesa, and the voters of NCSD recently rejected participation in the State Water Project (SWP). Thus, NCSD is not anticipated to import water to the area. However, NCSD's wastewater collection system and centralized treatment plant provide not only for land treatment (with nitrogen reduction) but also for groundwater recharge.

In view of the foregoing, NCSD has a goal of establishing its rights to the local groundwater. These resources are shared by another major purveyor, California Cities Water (CCW), as well as by various smaller purveyors, certain industrial pumpers, and numerous agricultural and private rural pumpers.

The Nipomo Mesa Sub-area is one groundwater unit within the Arroyo Grande Groundwater Basin (AGGWB), as defined by the State of California, Department of Water Resources (DWR) in their June 1979 Report (1). It is flanked by two other subareas: Arroyo Grande - Tri-Cities Mesa (AGTCM) to the north; and Santa Maria Valley (SMV) to the south (Figure I-1). Primarily for hydrogeologic reasons, DWR established the boundaries of the AGGWB as nearly to Price Canyon and Pismo Beach to the north, U.S. 101 to the north east, the Santa Maria River (about same as San Luis Obispo: Santa Barbara County Line) to the south, and the offshore aquifers of beyond the coastline to the west. Within these overall boundaries of the AGGWB, the Nipomo Mesa Sub-area (NMSA) is defined topographically as the high central mesa lands, with bluffs to the south and north.

Although all sub-areas of the AGGWB experience recharge by deep percolation of precipitation, the NMSA is unique in that it has no stream bed recharge of the underlying aquifers. In contrast, AGPTCM is fed by Arroyo Grande Creek as well as by Los Berros Creek. Similarly, the groundwater within SMV is influenced by the flow of Santa Maria River and, to a smaller extent, by the inflow from Nipomo Creek. Neither Los Berros Creek nor Nipomo Creek has a base flow but they both carry runoff at times of heavy rainfall. They both border NMSA to the northeast (just easterly of U.S. 101) but apparently have not been considered by DWR to contribute to the recharge of NMSA because of the general absence of alluvial deposits in that area. Although there are water wells within the Town of Nipomo and elsewhere in the Nipomo Valley, these wells are not generally as deep as those westerly of U.S. 101 and they typically penetrate shale, as opposed to sands, gravels, and clays in the NMSA. Thus, groundwater conditions within the Nipomo Valley (Figure I-1) are of primary interest to those in the adjacent NMSA in suggesting groundwater gradients for subsurface inflow from the northeast.

As part of NCSD's interests in establishing its rights to local groundwater, it is necessary to consider not only pumpages of various parties but also the basic dependable yield of the NMSA. The major municipal groundwater pumpage is metered, thereby establishing the current and historical groundwater production of these purveyors. Some metered water pumping data are also available from some of the smaller water purveyors and from certain industries. However, metered pumpage data are not available from most private pumpers as well as from agricultural pumpers.

In appraising the yield of the AGAGWB for their June, 1979 Report (1), DWR made estimates of pumpages and other factors entering into the hydrological balance. The DWR effort represented the most comprehensive study of the groundwater resources of the area to date. Subsequent studies have attempted limited updates of the earlier DWR work for certain Nipomo Mesa areas. Examples of these have been the June 1982 report by James M. Montgomery, Consulting Engineers, Inc. (2) regarding the proposed Black Lake Project, and the August 24, 1987 by Lawrance, Fisk & McFarland, Inc. (LFM) for the Nipomo Mesa Technical Study Sponsors (3). Additionally, The Morro Group provided a later assessment of groundwater yield for the Nipomo Mesa in connection with the 1990 Environmental Impact Report for South County Area Plan (4).

The intent of the current report on engineering considerations of groundwater yields and rights on the Nipomo Mesa Sub-area is to update and extend the previous study work to the best extent practical for realization of the NCSD goal stated above. Accordingly, the remaining Sections of this report are organized as follows:

| | |
|---|---|
| Section II - | Basic Data |
| Section III - | Data Analysis |
| Section IV - | Apportionment of Safe Yield |
| Section V - | Conclusions |

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## II - BASIC DATA

In order to accomplish the NCSD goal set forth in Section I, it is necessary to consider current and historical pumpages of various parties using the NMSA and all of the other factors that influence the yield of the NMSA.

### PUMPAGE DATA

Data on NCSD pumpage have been obtained directly from NCSD, while those for CCW, 1977-1985, have been derived from reports previously mentioned and, for 1986-1992, via NCSD.

NCSD PUMPAGE

| Calendar Year | Total Pumpage Acre-feet |
|---|---|
| 1979 | 500 |
| 1980 | 575 |
| 1981 | 580 |
| 1982 | 590 |
| 1983 | 710 |
| 1984 | 725 |
| 1985 | 787 |
| 1986 | 818 |
| 1987 | 878 |
| 1988 | 1,149 |
| 1989 | 1,129 |
| 1990 | 1,376 |
| 1991 | 1,439 |
| 1992 | 1,451 |

CCW PUMPAGE

| Calendar Year | Total Pumpage, Acre-feet |
|---|---|
| 1977 | 386 |
| 1978 | 362 |
| 1979 | 478 |
| 1980 | 470 |
| 1981 | 492 |
| 1982 | 493 |
| 1983 | 541 |
| 1984 | 654 |
| 1985 | 696 |
| 1986 | 770 |
| 1987 | 800 |

| | |
|---|---|
| 1988 | 932 |
| 1989 | 1,150 |
| 1990 | 1,184 |
| 1991 | 1,072 |
| 1992 | 1,102 |

**PUMPAGE BY OTHER PURVEYORS**

Metered water pumpage data for the smaller purveyors operating on the Nipomo Mesa are not available, according to the San Luis Obispo County Environmental Health Services (EHS). However, uptodate data were provided on the numbers of active service connections for these purveyors. The numbers provided for 1993 conditions are shown below and compared with corresponding data for Spring, 1986, as shown in the 1987 Report by LFM (3).

| Small Purveyor on Nipomo Mesa | Number of Service Connections 1993 | 1986 | Ratio: 1993/1986 |
|---|---|---|---|
| Las Flores W. Co. | 16 | 13 | 1.23 |
| Mesa Dunes Mobile Home Park | 187 | 187 | 1.00 |
| Nunes Water Co. | 14 | 13 | 1.08 |
| Rural Water Co. | 205-225 | 100 | 2.05-2.25 |
| Woodland Park Mutual W. Co. | 68 | 63 | 1.08 |
| Nipomo Mesa Mutual W. Co. | 8 | 8 | 1.00 |
| Laguna Negra Mutual W. Co. | 28 | 26 | 1.08 |
| Callendar Water Association | 7 | 7 | 1.00 |
| Mutual Water Assn. | 15 | 15 | 1.00 |
| La Mesa Mutual Water Company | 11 | 8 | 1.38 |
| Black Lake Canyon Water Supply | 8 | 8 | 1.00 |
| Black Lake Golf (C.S.A. 1) | 240 | 40 | 1.00 6.0 ± |
| Dana Elementary School | 1 | 1 | 1.00 |
| True Water Company | 5 | 5 | 1.00 |
| **Total Service Connections, Small Purveyors** | **613-633** | **494** | **1.24-1.28** |

The 1986 production of the small water purveyors was estimated by LFM as being 270 acre-feet per year (AFY), corresponding to about 0.55 AFY/service connection. Assuming that the same ratio of demand per service connection is generally applicable, the indicated pumpage for these small water purveyors during 1993 would be about 343 AFY.

PUMPAGE FROM PRIVATE WELLS

The pumpage from private wells was previously estimated by LFM on the basis of population data obtaining for 1986. The County of San Luis Obispo Department of Planning and Building provided LFM with current data on population for South County, including the estimated 1990 condition and projected future populations each 5 years. The breakdown was according to Nipomo (Urban) and Nipomo (Rural). As is customary, the data include certain areas that are actually off Nipomo Mesa but contiguous to it. The projected population data are understood to be scheduled for updating later during 1993, but have been accepted as provided for the purposes of this report.

LFM's use of the population data is as follows:

| Item | 1986 | 1990 | 1993 | 1995 |
|---|---|---|---|---|
| Nipomo Populations: | | | | |
| Urban, Total | - | 8,063 | 8,706 | 9,134 |
| Urban, Served by NCSD and CCW | 6,850 | 8,000 | 8,650 | 9,070 |
| Rural, Total | 7,000 | 7,533 | 7,850 | 8,022 |
| Rural Mesa, by Small Purveyors & Private Wells | 6,300 | 6,780 | 7,065 | 7,220 |
| Rural Mesa, by: | | | | |
| Small Purveyors | 1,600 | 1,830 | 2,000 | 2,100 |
| Private Wells | 4,700 | 4,950 | 5,065 | 5,120 |

In the above data, it has been assumed that 90 percent of the population listed under "Nipomo (Rural)" actually reside on the Nipomo Mesa and are supplied either by small purveyors or private wells. Data for 1986 are from the LFM Report (3). Data for 1993 are by LFM, interpolating between County-supplied data for 1990 and 1995.

As regards the Nipomo urban area, the 1986 pumpages by NCSD and CCW were 818 AFY and 760 AFY, respectively, for a combined pumpage of 1,578 AFY, corresponding to an estimated population of 6,850 persons or about 0.23 acre-foot/year/capita (AFYc). Nearly all of the urban area is served by these two major purveyors.

The 1990 condition involved 1,376 AFY pumpage by NCSD and 1,184 AFY pumpage for CCW for a combined major purveyor pumpage of 2,560 AFY. This is a 60 percent increase over the 1986 combined pumpage. When applied to the County-estimated Nipomo Urban Area population of 8,063 persons, this corresponds to a theoretical gross unit usage rate of 0.317 AFYc. This unit rate is about 36 percent higher than the 1986 value but may be due to a proportionately greater proportion of CCW production than in 1986. CCW has normally experienced somewhat greater per capita (and greater per service connection) consumption than NCSD. Also, the drought was more noticeable during 1990 than in 1986, probably inducing consumers to increase their water consumption, particularly for exterior water usage in landscape irrigation.

The population served by small water purveyors is approximated on the basis of an assumed 3.2 persons per service connection, corresponding to the previously-noted average unit consumption value of 0.55 AFY/service connection or 0.172 AFYc (about 153 gpcd). For private wells-served populations on the Nipomo Mesa, a slightly higher per capita usage is allowed (0.181 AFYc or 162 gpcd). The rural populations not served by small purveyors are served by private wells.

UNOCAL PUMPAGE

Current pumpage data obtained by NCSD from UNOCAL for their refinery in the southwestern Mesa is to the effect that pumpage averages 850 gpm (1,370 AFY) constantly with a recharge of 50 gpm (80 AFY). The net extraction is 800 gpm or 1,290 AFY.

AGRICULTURAL PUMPAGE

Agricultural irrigation pumpage is unmetered and requires estimation on the basis of land use, cropping patterns, and unit application rates. The LFM 1987 Report (3) made use of the 1984 Land Use Survey by DWR for Nipomo Mesa and other areas in San Luis Obispo County, and estimations of agricultural irrigation pumpage were made in consultation with DWR, the San Luis Obispo County Cooperative Extension, and the San Luis Obispo County Agricultural Commission. Information received by LFM from DWR concerning this current report has been to the effect that the 1984 land use survey represents the latest such survey for the area. DWR intends to conduct another land use survey in about 1993 or 1994, but this would not be timely for purposes of this investigation. Therefore, it was necessary to use the older information as the basis of current conditions, but with suitable updates as advised by the Cooperative Extension and County Agricultural Commission.

Both the Cooperative Extension and County Agricultural Commission have indicated that much of the irrigated acreage of the 1984 land use survey remains unchanged. However, there has been a significant increase in the lands devoted to greenhouse agriculture (nurseries) during the past 7 years, and a dropoff in pasture during 1989-90. Also there was a reduction in citrus and subtropical orchards during 1990-92, mostly as a result of winter freezing and economic considerations.

The net result has been a decrease in the estimate for agricultural pumpage from 2,453 AFY in 1985 to 2,136 AFY in 1992.

## TOTAL PUMPAGE

Based upon the foregoing, the current LFM estimates of recent and near-future pumpage on NMSA are as follows:

| Pumpage, AFY | 1986 | 1990 | 1993 | 1995 |
|---|---|---|---|---|
| Major Purvey. | 1,600 | 2,560 | 2,600 | 2,650 |
| Small Purvey. | 270 | 315 | 343 | 361 |
| Private Dom. | 850 | 895 | 916 | 926 |
| UNOCAL | 1,320 | 1,370 | 1,370 | 1,370 |
| Irrig. Agric. | 2,450 | 2,400 | 2,136 | 2,136 |
| Total | 6,490 | 7,540 | 7,365 | 7,443 |

## RAINFALL DATA

Table II-1 presents an "LFM Analysis of Nipomo Mesa and Vicinity Annual Rainfall and Deviations from Long-Term Mean Values." The basic data (historical annual rainfall) were provided by San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD), and they include 3 rain gages on the Nipomo Mesa, one gage in the City of Arroyo Grande, and the CalPoly rain gage, whose record began in 1869-70.

In this array, emphasis is placed upon the Nipomo Rain Gage (Town of Nipomo) whose record commenced in 1920-21. Inclusion of the other rain gage records in the array is for the purpose of indicating general similarity of seasonal experience of the several gages. For example, during the 1965-66 rainfall season, the Division of Forestry gage (Sta 151.1) registered 75.5 percent of that gage's long-term mean rainfall. Similarly, Nipomo Gage (Sta 038.0) registered 88.5 percent of its long-term mean, Upper Los Berros gage (Sta 175.1) showed 50.8 percent of its long-term mean, and CalPoly (Sta 001.0) showed 71.7 percent.

By virtue of its relatively long record and generally centralized location, Sta 038.0 (Nipomo) is deemed appropriate to indicate the year-to-year fluctuations in rainfall on the NMSA and therefore the approximate effects of aquifer recharge by deep percolation of rainfall. The cumulative deviation from mean annual rainfall is a running account of decimal percentage deviation, as calculated for Sta 038.0 (Nipomo).

For reference purposes, the starting point of this cumulative deviation from mean rainfall accounting has been taken as the end of the 1966-67 season rather than at the commencement of the historical record (1920-21). In the DWR June 1979 Report (1), a 31-year base period for supply was chosen and corresponded to 1935-36 through 1966-67. DWR reported that this base period was representative of average climatic conditions in the Arroyo Grande area in which hydrologic conditions prevailing at its beginning and at its end were similar. According to DWR, the based period began during a dry period and ended at the next similar dry period. Although the Nipomo Rain Gage (Sta 038.0) actually showed recovery from the initial dry period beginning in 1934-35 and the ending dry period beginning in 1965-66, this discrepancy is not considered

TABLE II-1 - LFM ANALYSIS OF NIPOMO MESA AND VICINITY ANNUAL RAINFALL AND DEVIATIONS FROM LONG-TERM MEAN VALUES

| RAINFALL SEASON | STA 151.1 INCHES | DIV. BY 14.72 | STA 038.0 INCHES | DIV. BY 16.12 | STA 175.1 INCHES | DIV. BY 18.21 | STA 001.0 INCHES | DIV. BY 21.79 | STA 205.0 INCHES | DIV. BY 12.25 | CUM DEV FR MN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1961 | 5.68 | 0.386 | 9.90 | 0.614 | | | 11.13 | 0.511 | | | 0.565 |
| 1962 | 18.92 | 1.285 | 22.60 | 1.402 | | | 25.99 | 1.193 | | | 0.967 |
| 1963 | 11.82 | 0.803 | 15.02 | 0.932 | | | 24.80 | 1.138 | | | 0.898 |
| 1964 | 11.11 | 0.755 | 11.81 | 0.733 | | | 14.68 | 0.674 | | | 0.631 |
| 1965 | 12.26 | 0.833 | 17.14 | 1.063 | | | 21.84 | 1.002 | | | 0.694 |
| 1966 | 11.12 | 0.755 | 14.18 | 0.880 | 9.25 | 0.508 | 15.62 | 0.717 | | | 0.574 |
| 1967 | 16.25 | 1.104 | 22.99 | 1.426 | 34.37 | 1.887 | 33.75 | 1.549 | | | 1.000 |
| 1968 | 10.31 | 0.700 | 11.37 | 0.705 | 7.25 | 0.398 | 17.94 | 0.823 | | | 0.705 |
| 1969 | 26.86 | 1.825 | 29.21 | 1.812 | 28.24 | 1.551 | 54.53 | 2.503 | | | 1.517 |
| 1970 | 11.55 | 0.785 | 11.87 | 0.736 | | | 16.40 | 0.753 | | | 1.254 |
| 1971 | 13.00 | 0.883 | 14.49 | 0.899 | | | 20.46 | 0.939 | | | 1.153 |
| 1972 | 6.24 | 0.424 | 7.06 | 0.438 | | | 12.42 | 0.570 | | | 0.591 |
| 1973 | 22.01 | 1.495 | 25.60 | 1.588 | | | 40.01 | 1.836 | | | 1.179 |
| 1974 | 19.09 | 1.297 | 22.70 | 1.408 | | | 31.73 | 1.456 | | | 1.587 |
| 1975 | 17.29 | 1.175 | 15.84 | 0.983 | | | 24.16 | 1.109 | | | 1.569 |
| 1976 | 8.50 | 0.577 | 8.73 | 0.542 | | | 10.42 | 0.478 | | | 1.111 |
| 1977 | 15.10 | 1.026 | 14.59 | 0.905 | | | 16.87 | 0.774 | | | 1.016 |
| 1978 | 29.29 | 1.990 | 31.42 | 1.949 | 39.45 | 2.166 | 47.85 | 2.196 | | | 1.965 |
| 1979 | 17.07 | 1.160 | 18.24 | 1.132 | | | 20.76 | 0.953 | | | 2.097 |
| 1980 | 16.70 | 1.135 | 18.78 | 1.165 | 21.35 | 1.172 | 33.26 | 1.526 | | | 2.262 |
| 1981 | 13.44 | 0.913 | 15.69 | 0.973 | | | 18.77 | 0.861 | | | 2.235 |
| 1982 | 17.98 | 1.221 | 20.07 | 1.245 | 22.63 | 1.243 | 27.31 | 1.253 | 12.78 | 1.043 | 2.480 |
| 1983 | 33.18 | 2.254 | 37.79 | 2.344 | 38.01 | 2.087 | 47.39 | 2.175 | 24.15 | 1.971 | 3.824 |
| 1984 | 11.85 | 0.805 | 12.52 | 0.777 | 14.03 | 0.770 | 19.78 | 0.908 | 9.84 | 0.803 | 3.601 |
| 1985 | 12.13 | 0.824 | 12.86 | 0.798 | 13.70 | 0.752 | 14.74 | 0.676 | 8.91 | 0.727 | 3.399 |
| 1986 | 15.60 | 1.060 | 18.93 | 1.174 | 22.16 | 1.217 | 29.43 | 1.351 | 18.57 | 1.516 | 3.573 |
| 1987 | 12.61 | 0.857 | 14.17 | 0.879 | 5.25 | 0.288 | 15.19 | 0.697 | 5.90 | 0.482 | 3.452 |
| 1988 | 12.66 | 0.860 | 14.73 | 0.914 | 18.07 | 0.992 | 19.85 | 0.911 | 12.43 | 1.015 | 3.366 |
| 1989 | 11.31 | 0.768 | 11.86 | 0.736 | 15.97 | 0.877 | 15.46 | 0.709 | 9.39 | 0.767 | 3.102 |
| 1990 | 7.50 | 0.510 | 8.03 | 0.498 | 11.27 | 0.619 | 13.60 | 0.624 | 5.67 | 0.463 | 2.600 |
| 1991 | 13.59 | 0.923 | 17.16 | 1.065 | 20.98 | 1.152 | 18.55 | 0.851 | | | 2.664 |
| 1992 | 15.09 | 1.025 | 17.23 | 1.069 | | 0.000 | 22.14 | 1.016 | 14.87 | 1.214 | 2.733 |
| 1993 | 20.74 | 1.41 | 23.04 | 1.43 | | | 30.90 | 1.42 | 17.95 | 1.47 | |
| 1994 | | | | | | | | | | | |

NOTES:

1. LAST YEAR OF ANNUAL RAINFALL SEASON IS LISTED (E.G., 1961 = 1960-61). DIVISOR IS LONG-TERM MEAN VALUE.
2. STA 151.1 IS NIPOMO (STATE DIV FORESTRY)(BEGINNING 1958-59).
3. STA 038.0 IS SLOCOFCWCD, NIPOMO (BEGINNING 1920-21)
4. STA 175.1 IS SLOCOFCWCD, UPPER LOS BERROS (BEGINNING 1965-66).
5. STA 001.0 IS CALPOLY, SAN LUIS OBISPO (BEGINNING 1869-70).
6. STA 205.0 IS ARROYO GRANDE, COUNTY YARD, TOTAL RECORD.
7. 1967-68 STARTS NEW CYCLE, FOLLOWING DWR BASE PERIOD (END 1966-67).
8. CUMULATIVE DEVIATION FROM MEAN IS FOR STA 038.0.
9. FOR CONVENIENCE IN PLOTTING, ASSUME THAT DEV. = 1.000 AT START.

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important for the purposes of this study. Rather, it is intended that Table II-1 illustrate the manner in which the overall rainfall since the end of the DWR-used base period, has been substantially above long-term average for Sta 038.0. This can be seen by the net change in cumulative deviations from long-term mean annual rainfall values during periods of time.

For example, between 1965 and 1975, the cumulative deviation rose from 0.694 to 1.569 or 0.875 or about 8.8 percent per year above-average rainfall for Sta 038.0. Similarly, from 1975 to 1985, the values rose from 1.569 to 3.399 or a 10-year average annual rise of more than 18 percent above long-term mean. The recently-broken drought began in 1986-87 and showed a drop of cumulative deviation for Sta 038.0 from 3.573 to 2.733 at the end of 1991-92 for an average annual deficiency of about 14 percent below mean long-term rainfall.

WATER LEVEL DATA

SLOCFCWCD maintains a program of measurement of standing water levels in many water wells throughout San Luis Obispo County, including on NMSA and vicinity. Measurements are normally made both spring and fall. Well water levels respond negatively to pumpage and positively to aquifer recharge. The degree to which these responses occur varies widely among individual wells, their depths, extents and water-yielding capacities of aquifers penetrated, and the recharge characteristics of the affected aquifers. All of these items tend to vary widely in the wells observed by SLOCCFCWCD on the NMSA. However, well water levels are an essential element in the determination of groundwater basin yields and are always considered in such calculations. Only standing water levels (as opposed to pumping levels) are considered in assessing general water levels, quantity of groundwater in storage, and groundwater movement.

The spring well water levels normally precede the periods of greatest pumping and may sometimes reflect at least some of the recharge experienced by the previous rainy season's rainfall. Attempts to obtain well water level measurements in the spring rarely are thwarted by active pumping taking place.

In contrast, fall water levels tend to reflect the summer pumping and normally are lower than the spring levels. As such, they may give the better indication of stress on the groundwater aquifers under the influence of local wells. Unfortunately, there may be occasions during the fall measurement program when a particular well is still being actively pumped, thereby negating the validity of its water level data.

It is useful to consider both spring and fall levels, where both are available. However, either of these levels, spring or fall, is acceptable for studying groundwater basins. In the DWR June, 1979 Report (1), Fall Water levels were used for 1965 and 1975 to depict approximate groundwater contours in the AGGWB. Storage quantities were calculated by DWR for 1967 and 1975 for NMSA. The LFM 1987 Report (3) plotted Spring well water standing levels for many wells within NMSA and calculated storage change between Fall, 1975 conditions and Fall, 1985 conditions.

In studying well water levels for the NMSA it is convenient to utilize index wells scattered about the Nipomo Mesa that may be considered as representative of groundwater conditions in their respective localities. Also, it is advisable to consider wells whose production is both major and metered, if not otherwise included with the index wells, to facilitate investigation of local areas of depressed water levels dewatering, so-called "pumping holes."

Table II-2 presents a summary of wells in or near NMSA for which water levels data are available, the basic data having been supplied by San Luis Obispo County Engineering Department. Included with the data concerning well depths and well bottom elevations are representative elevations (above mean sea level) of standing levels observed in the spring of the years listed. In many instances, the response to droughts as well as to periods of above-average rainfall may be evident.

For example, in the Northwest Mesa Area, Well No. 12N35W. ., which extends to some 130 ft below mean sea level (MSL) appears to indicate some sensitivity to rainfall conditions, having dropped in water level during the 1976-77 drought, recovered following the 1978 wet year, and declined again during the recent (1987-92) drought. Spring standing levels in Well No. 12N35W , which is a very shallow well, also fluctuated, but a gradual lowering trend is suggested.

On the other hand, Well No. 12N35W , a deeper well, shows moderate fluctuations but no definite trend in declining levels.

Long-range lowering trends in spring standing levels are suggested in the data for the North-Central Mesa Wells Nos. 12N35W and . The first mentioned well extends below sea level, but the second one does not. On the other hand, Well No. 12N35W showed a stable pattern.

In the Northeast area, the wells do not penetrate unconsolidated formations, and the wells east of U.S. 101 are drilled into shales. Thus, from a technical standpoint they lie outside NMSA. Well 11N34W showed a stable pattern but Well 11N34W , a deeper well, showed a declining pattern.

The East-Central Area is also technically outside NMSA, but the water levels in the wells drilled into the consolidated formations tend to reflect water conditions, both recharge and pumpage. For example, Well No. 11N34W shows considerable fluctuations in its standing water level but no long-range trends. On the other hand, Wells Nos. 11N34W and show some decline since the onset of the most recent drought and no recovery yet. The same is true of Well No. 12N34W's levels.

The wells listed on the Southeast Mesa are all within NMSA. Their standing water levels shown in Table II-2 show fluctuations but no definite trends.

In contrast, the wells shown in the South-Central Mesa (for which data are relatively limited) do indicate declining water levels. However, the standing levels of wells in Santa Maria Valley do not suggest any trends but only show fluctuations. Santa Maria Valley groundwater levels are known to be strongly influenced by basin recharge from Twitchell Reservoir during wet years. It is understood that a lag period of one or two years is often experienced between major recharge and major rise in water levels. Because of the relatively low ground levels in Santa Maria Valley, the wells typically extend below mean sea level.

Wells in the Southwest Mesa area tend to be deep and extend well below sea level. Well No. 11N35W has a substantial record of level observations and shows considerable fluctuation, apparently in response to wet-years and drought conditions. For example, the standing level dropped to well below sea level in spring 1977 (during the 1976-77 drought) but recovered following the heavy rains of 1978. However, it was slightly below sea level during both 1980 and 1985. The much more limited record of 11N35W showed only mild fluctuations and no standing levels even approaching MSL.

The Coastal Dunes wells include both a production well and a seawater intrusion monitoring well. The production well, No. 11N35W is fairly shallow and shows very stable conditions, with standing levels comfortably above MSL. The monitoring well is very deep, extending hundreds of feet below sea level, and is equipped with multiple piezometers tapping three successive aquifers. Each level tapped shows mildly fluctuating water levels which remain comfortably above MSL. It is of interest to note that the deepest aquifer shows the mildest fluctuations and the greatest average standing water level.

The West-Central Mesa wells vary in depth. Some are relatively shallow and do not extend below sea level, while others are fairly deep and may extend several hundred feet below MSL. The standing level characteristics of these wells tend to vary. For example, Well No. 11N35W s standing levels display very little fluctuations and a generally stable condition, 1975-92. Three neighboring wells ( and ) greater fluctuations but no distinct trends in standing levels. However, 11N35W 's level is seen to be below sea level 5 out of 9 observations listed in Table II-2. This suggests the existence of a "pumping hole." Elsewhere in the West-Central Mesa, the levels for 11N35W suggest a downward trend or else delayed recovery from the 1987-92 drought. The levels for are somewhat similar.

In the Central Mesa, Well No. 11N35W exhibits great stability as does . Others show more fluctuations but no definite trends.

In the Cienega Valley (adjacent to the Northwest Mesa and technically outside of NMSA) water level fluctuations vary from mild to moderate, and half of the wells listed have experienced water levels below sea level.

TABLE II – 2 – SUMMARY OF WELL WATER LEVELS AND TRENDS, NIPOMO MESA SUB – AREA AND VICINITY

| MESA AREA REPRESENTED | TOWNSHIP SECTION & RANGE | LEVELS OBSERVED FROM | TO | CONT.? | WELL DEPTH,FT | BOTTOM | TOP REF. | ELEVATIONS, FEET MEAN SEA LEVEL (SPRING) 1965 | 1970 | 1975 | 1977 | 1979 | 1980 | 1985 | 1986 | 1990 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northwest | 12N35W | | | | 86 | 64 | | | | | | | | | | | | |
| | | 04/65 | 04/93 | Y | 82 | 80 | 162 | 151.6 | 156.8 | | 146.8 | 161.7 | 161.8 | 157.1 | 155.6 | – | 146.3 | 153.0 |
| | | 05/75 | 04/93 | Y | | | 181 | – | – | 144.3 | 142.5 | 144.5 | 144.5 | 127.7 | 135.7 | 120.7 | – | 129.9 |
| | | 10/68 | 04/93 | Y | 300 | 50 | 250 | – | 51.5 | 55.4 | 49.5 | 54.2 | - | – | 51.1 | 44.4 | 69.8 | 54.3 |
| | | 05/75 | 04/93 | Y | 320 | –130 | 190 | – | – | 15 | 7.4 | 18.4 | 15.1 | 17.3 | 19.6 | 7.5 | 5.7 | 12.4 |
| N–Central | 12N35W | 05/75 | 04/93 | Y | | | 280 | – | – | 123.4 | 123.7 | 123.7 | 124.0 | 122.8 | 123.6 | 122.5 | 121.1 | 120.6 |
| | | 11/74 | 04/93 | Y | 443 | –142 | 301 | – | – | 54.5 | – | 49.3 | 48.5 | 49.3 | 51.5 | 45.2 | 41.9 | 42.4 |
| | | 11/74 | 04/93 | N | 407 | 137 | 270 | – | – | – | – | 22.8 | 20.5 | – | 24.1 | 18.2 | – | 15.1 |
| | | 04/65 | 10/92 | N | | | | 163.0 | 164.1 | 163.0 | 159.3 | – | 172.1 | – | 167.7 | 138.2 | 158.8 | |
| | | 05/75 | 10/92 | Y | | | 305 | – | – | 25.9 | 22.0 | 21.6 | 25.5 | 25.6 | 26.2 | 19.2 | – | 17.0 |
| | | 10/75 | 04/93 | Y | 300 | –53 | 247 | – | – | – | –6.4 | –6.1 | –3.3 | –3.2 | –0.7 | –11.9 | –3 | –11.9 |
| | | 05/75 | 04/93 | N | | | 340 | – | – | 160.7 | 159.7 | 159.5 | 156.7 | 157.8 | 157.5 | 155.5 | 154.5 | 153.4 |
| | | 04/65 | 04/93 | N | 75 | 84.3 | 159 | 129.6 | 138.3 | 141.7 | 119.5 | 140.8 | 141.0 | 135.6 | 132.9 | 109.2 | 121.6 | |
| | | 04/65 | 10/92 | N | 70 | 129 | 199 | 171.8 | 179.5 | 183.2 | 165.3 | 184.0 | 184.6 | 174.0 | 171.2 | – | – | – |
| | | 05/75 | 04/93 | N | | | 190 | – | – | 170.4 | – | 172.1 | 171.0 | – | – | 133.7 | – | – |
| | | 11/74 | 04/93 | Y | 280 | 110 | 391 | – | – | 220.6 | 200.2 | – | 181.5 | – | 192.3 | 187.2 | 169.1 | 162.7 |
| | | 11/74 | 04/91 | N | 270+ | 120 | 391 | – | – | 198.3 | 201.5 | 173.3 | 173.2 | – | 176.5 | 175.8 | – | |
| | | 04/81 | 04/93 | Y | | | 390 | – | – | – | – | – | – | 160.0 | 159.3 | 156.1 | 155.5 | 154.2 |
| Northeast | 12N35W | | | | | | | | | | | | | | | | | |
| | 11N35W | 11/74 | 10/92 | N | 130 | 270 | 400 | – | – | 302 | 302.6 | 303.2 | 303.9 | 308 | 301.1 | 310.8 | 308.3 | 306.5 |
| | | 10/76 | 10/92 | Y | 180 | 200 | | – | – | – | 347.9 | 366.4 | 357.5 | – | 356.4 | 346.3 | 351.1 | |
| | | 10/75 | 10/92 | N | 350 | 50 | | – | – | – | 331.2 | 358.7 | 324.1 | – | 309 | 243.5 | 233.3 | |
| | | 05/83 | 10/92 | N | | | | – | – | – | – | – | – | 264.3 | | – | – | |
| | | 05/83 | 10/92 | N | | | | | | | – | – | – | 252.3 | – | 177.2 | 178.3 | |
| E–Central | 11N34W | 09/74 | 04/92 | Y | 80 | 261 | 341 | – | – | 325.3 | 300.6 | 321 | 323.5 | 309.6 | 308.7 | 274.3 | 341.0 | |
| | | 04/70 | 04/93 | Y | 312 | 68 | 376 | – | 300.8 | 307.5 | – | – | 301.4 | 287 | 293.9 | – | 264 | 281.9 |
| | | – | – | – | – | – | | – | – | – | – | – | – | – | – | – | 230.0 | |
| | | 10/75 | 04/93 | Y | 225 | 85 | 310 | – | – | 293.4 | 275.6 | 291.3 | 292.8 | 282.6 | 273.7 | 310 | 238.6 | 265.2 |
| | | – | 04/93 | | – | – | 310 | – | – | – | – | – | – | – | – | – | 234.0 | 229.0 |
| | | | | | 393 | | | | | | | | | | | | | |
| | 12N34W | 12/74 | 04/92 | N | | | 442 | – | – | 375.3 | – | 377.8 | – | 352.3 | 368.9 | – | 348.0 | |
| Southeast | 11N34W | 10/83 | 04/93 | N | | | 320 | – | – | – | – | – | – | – | – | 46.0 | 44.0 | 49.0 |
| | | 10/83 | 11/92 | N | | | 315 | – | – | – | – | – | – | – | – | 74.0 | 63.0 | 54.0 |
| | | 04/73 | 04/93 | Y | 315 | 9 | 306 | – | – | 48.7 | 37.3 | 47.7 | 49.5 | 66.6 | 66.4 | 34.8 | 31.9 | 33.5 |
| | | 04/73 | 04/93 | Y | 135 | 161 | 296 | – | – | 175 | 176.4 | 178.5 | 179.9 | 186.1 | 185.1 | 178.6 | 176.5 | 176.0 |
| | | 04/75 | 04/93 | N | 285 | 20 | 305 | – | – | 128.5 | 125.1 | 117.8 | 124.1 | – | 138.5 | 124.9 | 120.9 | 118.0 |
| | | 10/73 | 04/93 | N | 185 | 103 | 288 | – | – | 160.9 | – | – | 162.2 | – | 181.3 | – | – | 156.5 |
| | | 04/73 | 10/92 | N | 163 | 3 | 166 | – | – | 62.9 | 44.5 | 71.4 | – | – | 99.3 | 54.6 | 55.1 | – |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 04/73 10/92 N | | | | – | – | 47.0 | 33.0 | 44.5 | 46.5 | 65.0 | 66.8 | | | |
| S–Central | 11N35W | 10/66 10/92 N | 575 | –300 | 275 | – | – | – | – | – | 25.4 | – | – | – | 13.4 | – |
| | | 10/83 11/92 N | | | 315 | – | – | – | – | – | – | – | – | 38.0 | 33.0 | 39.0 |
| | | 04/77 04/93 N | 620 | –295 | 325 | – | – | – | 63.1 | – | 50.0 | – | – | 1.0 | 3.0 | 41.0 |
| S.M. Valley | 11N35W | 04/73 11/92 Y | 129 | –61 | 68 | – | – | 25.9 | 7.5 | – | 18.1 | 25.0 | 37.5 | 10.9 | 48.3 | – |
| | | 10/76 04/93 N | 324 | –217 | 107 | – | – | – | – | – | 42 | 66 | 62.1 | 50.8 | 45.9 | 49.5 |
| | | 10/87 04/93 Y | 700 | –591 | 109 | – | – | – | – | – | – | – | – | 29.7 | – | 30.2 |
| | | | 585 | | | | | | | | | | | | | |
| | | | 328 | –227 | | | | | | | | | | | | |
| | | 04/73 04/93 Y | | | 80 | – | – | 26.0 | – | – | 51.8 | 61.9 | 63.8 | 52.5 | 50.1 | 51.7 |
| | | 10/88 11/92 Y | | | 60 | – | – | – | – | – | – | – | – | 13.9 | 15.3 | |
| Southwest | 11N35W | 11/66 04/92 Y | 548 | –350 | 198 | – | 16.7 | 15.9 | –10.5 | 18 | –1.6 | –2 | 28.8 | – | – | –2.0 |
| | | 11/71 04/92 N | 615 | –325 | 90 | – | – | – | – | – | 19.4 | 27 | – | 14.1 | – | 12.2 |
| Coast Dunes | 11N35W | 04/73 04/91 Y | 62 | 25 | 37 | – | – | 28.3 | 28.2 | 29.5 | – | 30 | 30.9 | 28.1 | – | |
| | 11N36W | 12/75 04/93 N | 290 | –271 | | – | – | – | 6.3 | 9.1 | – | 13.1 | 10.1 | 7 | 11.2 | 7.1 |
| | | 12/75 04/93 N | 460 | –441 | | – | – | – | 12.5 | 19 | – | 19 | 19 | 13.6 | 15.7 | 13.5 |
| | | 12/75 04/93 N | 730 | –711 | | – | – | – | 16.3 | 19 | – | 19 | 19 | 18.5 | 17.3 | 16.5 |
| W–Central | 11N35W | 04/73 04/93 N | 265 | 100 | 140 | – | – | 29.8 | 21.1 | 32.5 | 26.5 | – | 36.1 | 25 | 26.5 | 27.2 |
| | | 04/75 04/93 Y | 140 | 5 | 135 | – | – | 20.9 | 11.4 | 23.2 | – | 24.6 | 27 | 11 | 15.4 | 15.0 |
| | | 04/62 04/93 Y | 200 | 91 | 109 | –6.5 | –4.3 | 4.7 | –5.7 | 7.7 | 0 | – | 13 | –6 | –2.5 | –3.2 |
| | | 04/89 04/93 Y | | | ? | – | – | – | – | – | – | – | – | –5.9 | –10.6 | –0.5 |
| | | 02/75 04/93 N | 278 | 178 | 100 | – | – | 20.0 | – | – | – | 1.7 | 17.3 | 4.9 | 2.4 | 10.8 |
| | | 02/75 04/93 N | 240 | 100 | 140 | – | – | 24.9 | 10.5 | – | – | 23.5 | 29.2 | 11.8 | 16.1 | 17.3 |
| | | 05/75 04/93 Y | | | 101 | – | – | 25.2 | 22.8 | – | 24.8 | 26.5 | 28.8 | 21.8 | 21.4 | 21.7 |
| | | | 722 | –622 | | | | 17.1 | 6.1 | 18.9 | 3.4 | – | | | | |
| | | 07/83 04/91 N | 595 | 394 | 201 | – | – | –12.2 | – | –19.1 | – | – | – | – | – | |
| | | 04/73 04/93 N | 358 | –266 | 190 | – | – | 57 | 44 | 54.9 | 36.3 | – | 59.6 | 24.3 | 24.7 | 34.3 |
| | | 04/73 04/93 Y | 274 | 91 | 183 | – | – | 42.8 | 26.5 | 38.8 | 25.4 | 17.5 | 50 | 21 | 25.7 | 30.9 |
| | | 04/81 04/93 N | 727 | –420 | 180 | – | – | – | – | – | – | – | – | – | 28 | –16.0 |
| Central | 11N35W | 11/74 10/92 N | 390 | 9.0 | 381 | – | – | 47.7 | 45.3 | 45.8 | 42.5 | 47.4 | 48.2 | 45.3 | – | – |
| | | 11/74 04/93 N | 130 | 270 | 400 | – | – | 302 | 302.6 | 303.2 | 303.9 | 308.0 | 310.1 | 310.8 | 308.2 | 306.6 |
| | | 11/74 04/93 Y | 258 | 142 | 400 | – | – | 167.5 | 150.2 | 170.3 | 186.0 | 166.6 | 166.6 | 159.6 | 162.3 | 162.5 |
| | | 11/74 04/93 N | 310 | 10.5 | 321 | – | – | 100.3 | 99.3 | 97.9 | 98.1 | 97.5 | 43.3 | 91.7 | 90.0 | 88.5 |
| | | 10/66 04/93 N | 500 | –160 | 340 | – | – | – | – | – | – | – | 55 | 11.8 | – | 10.3 |
| | | | 799 | –479 | | | | | | | | | | | | |
| | | | 690 | –390 | | | | | 3.7 | | | | | | | |
| | | | 510 | | | | | | | | | | | | | |
| | | –– 10/92 N | 570 | –250 | 320 | – | – | – | – | – | – | – | – | – | – | 2.0 |
| | | 10/69 04/92 Y | | | 240 | – | 92.9 | – | 94.5 | 98.3 | – | 89.0 | 78.3 | 84.0 | – | |
| | | 04/73 04/93 Y | 372 | 13 | 385 | – | – | 48.1 | 44.0 | 39.2 | 37.5 | 66.0 | 62.2 | 60.6 | 52.4 | 64.8 |
| | | 10/85 10/92 Y | 312 | –27 | 285 | – | – | – | – | – | – | – | 57.9 | – | 48.8 | – |
| | | 04/73 04/93 N | 313 | 39 | 352 | – | – | 71.4 | – | 68.5 | 65 | 64.3 | 70.6 | 77.1 | 83.9 | 89.0 |
| | | 04/73 04/93 N | 500 | –155 | 345 | – | – | – | – | 57.4 | 55.1 | – | 59.6 | 56.1 | 53.9 | 47.5 |
| | | 04/73 04/93 Y | 430 | –124 | 306 | – | – | 61.9 | 61.0 | 68.2 | 63.8 | 57.0 | 62.7 | 69.0 | 67.9 | 50.1 |
| | | 04/73 04/93 N | | | 306 | – | – | 59.0 | 66.1 | 71.6 | 63.2 | – | 65.9 | 66.8 | 64.0 | 66.3 |
| | | – – – | – | – | 350 | – | – | – | – | – | – | – | – | – | – | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cienega Val. | 12N35W | | | 29 | 17.8 | – | 14.0 | –8.5 | 22.0 | 16.7 | 15.6 | – | – | 17.1 | 20.0 |
| | | | | 28 | – | 16.6 | – | – | 19.7 | 15.0 | 13.3 | – | 4.3 | 14.0 | 18.8 |
| | | | | 31 | – | 23.1 | 19.4 | 12.3 | – | 21.5 | 21.6 | 23.3 | – | 16.7 | 23.8 |
| | | | | 22 | 13.6 | 15.5 | – | 2.8 | 17.5 | 15.2 | 13.3 | 16.7 | –4.2 | 2.8 | 13.0 |
| | | | | 23 | – | – | – | – | – | – | – | – | – | – | 10.3 |
| | | | | 27 | 18.8 | 19.9 | 14.8 | 0.1 | 23.3 | 18.1 | 17.5 | 20.3 | –12.4 | 18.3 | 20.5 |
| | | 105 | –85 | | – | | | | | | | | | | |
| | 32S13E | | | 71 | 8.5 | 8.5 | 13.5 | 10.5 | 15.5 | 14.3 | 13.0 | 12.1 | 10.0 | 13.6 | 14.1 |
| | | | | 82 | 56.3 | 7.3 | 11.0 | – | – | 8.8 | 3.4 | –2.2 | 3.9 | 8.9 | 10.1 |
| | | 595 | –511 | 84 | – | – | – | – | – | 9.8 | 8.4 | 52.5 | 1.2 | 8.0 | 9.2 |
| | | | | 21 | 5.5 | – | 7.1 | 5.8 | 8.5 | 7.8 | 6.6 | 7.4 | 4.3 | 6.5 | 7.7 |
| | | 104 | –83 | 21 | 10.3 | 5.8 | 9.0 | 6.8 | 13.5 | 11.3 | 11.3 | –2.40 | – | – | – |
| | | | | 60 | – | – | 23.2 | – | 23.4 | 23.6 | 11.0 | – | 3.5 | – | 17.3 |
| | | 82 | –33 | 49 | 32.9 | – | 22.1 | – | – | 28.5 | 20.6 | 30.1 | – | – | 30.4 |
| | | 96 | –45 | 51 | – | – | 24.6 | 8.1 | 23.9 | 16.0 | 14.3 | 5.9 | 22.7 | – | 21.0 |
| | | – | – | 42 | – | – | – | – | – | – | – | – | – | 19.7 | 22.3 |
| | | | | 40 | 23.8 | 10.1 | – | 7.0 | – | 20.1 | – | – | – | – | – |

NOTES:
(1) DATA ARE FROM SAN LUIS OBISPO COUNTY ENGINEERING DEPARTMENT.
(2) TOP REFERENCE ELEVATION (FT., MSL) IS USUALLY THAT OF THE WELLHEAD, BUT MANY HAVE NOT BEEN SURVEYED AND ARE ESTIMATED FROM USGS QUAD SHEETS. THUS, ALL ELEVATIONS LISTED HAVE BEEN ROUNDED TO THE NEAREST INTEGER.
(3) WATER LEVELS ALSO USUALLY INCLUDE FALL OBSERVATIONS (NOT SHOWN). WATER LEVEL ELEVATIONS SHOWN ARE CALCULATED FROM MEASURED "STATIC" DEPTH FROM TOP REF. FOR SPRING OF YEAR SHOWN. ABSENCE OF A NUMBER DENOTES THAT NO MEASUREMENT WAS MADE (SOMETIMES BECAUSED THE WELL WAS BEING PUMPED.)
(4) SPRING, 1977 REFLECTS SHARP DROUGHT, 1976–77. SPRING, 1979 MAY REFLECT RECOVERY AFTER FLOODS OF 1978.

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NCSD EFFLUENT DISPOSAL DATA

During 1986-87, NCSD constructed a fairly extensive network of sanitary sewers and a sewage treatment plant employing "land treatment" techniques. The basic construction program was completed in 1988, but actual connection of buildings to the sewers (including diversion of flows from Nipomo Palms Mobile Home Subdivision, Black Lake Estates Mobile Home Subdivision, and Galaxy Mobile Home Subdivision Nos. 2 & 3) was not completed until about 1989. The treatment plant operates under the requirements of California Regional Water Quality Control Board, Central Coast Region (RWQCB) and Order No. 84-56 (July 18, 1984) of RWQCB. NCSD monitors itself and submits quarterly reports to RWQCB concerning influent quantity and quality as well as effluent quality. Additionally, water quality in three monitoring wells is monitored and reported to RWQCB quarterly. The location plan is shown on Figure II-1.

The initially-constructed NCSD Wastewater Treatment Plant (NCSDWWTP) comprises two aerated lagoons, normally operating in series, and three rapid infiltration basins, normally being rotated between filling, percolating, and drying and discing. One monitoring well ("A") was constructed with the other project facilities and is located in the northwest corner of the WWTP complex. It is identified as "pre-discharge". The other monitoring wells are located a few feet southeasterly of the farthest percolation pond and are identified as Percolation Pond Monitor #1 ("C") and #2 ("B").

The design criteria for the WWTP show an average dry-weather flow (ADWF) capacity of 0.36 million gallons per day (mgd) and influent 5-Day Biochemical Oxygen Demand ($BOD_5$) and Suspended Solids (SS) concentrations of 255 mg/l and 300 mg/l, respectively. The WWTP is designed to reduce the concentration of pollutants to acceptable levels, including prevention of the effluent causing nitrate nitrogen (N) concentrations in the groundwater downgradient from the WWTP disposal area from exceeding 10 mg/l.

Two representative quarterly reports were reviewed by LFM, for the months of July in both 1991 and 1992. These indicated that the WWTP is operating at about 62 percent of capacity and that the quantity of influent to the WWTP in July, 1992 averaged about 0.225 mgd (equivalent to about 252 AFY). The July, 1991 influent metering equipment was out of repair, so the flows reported were estimated from influent pump station operating times (for 0.167 mgd or nearly 190 AFY). The monitoring wells are used for water quality sampling as well as water level observation., Limited data (April, 1993) suggest a mounding effect of the effluent percolation on the underlying aquifer, particularly at Monitoring Well C.

In addition, the reports submitted to RWQCB include the quality characteristics of the plant effluent and the three monitoring wells (Nos. A, B, and C). The analyses are for Total Dissolved Solids (TDS), nitrate ($NO_3$), sodium (Na), chloride (Cl), sulfate ($SO_4$), and boron (B). RWQCB Order No. 84-56 required that no significant increase of mineral

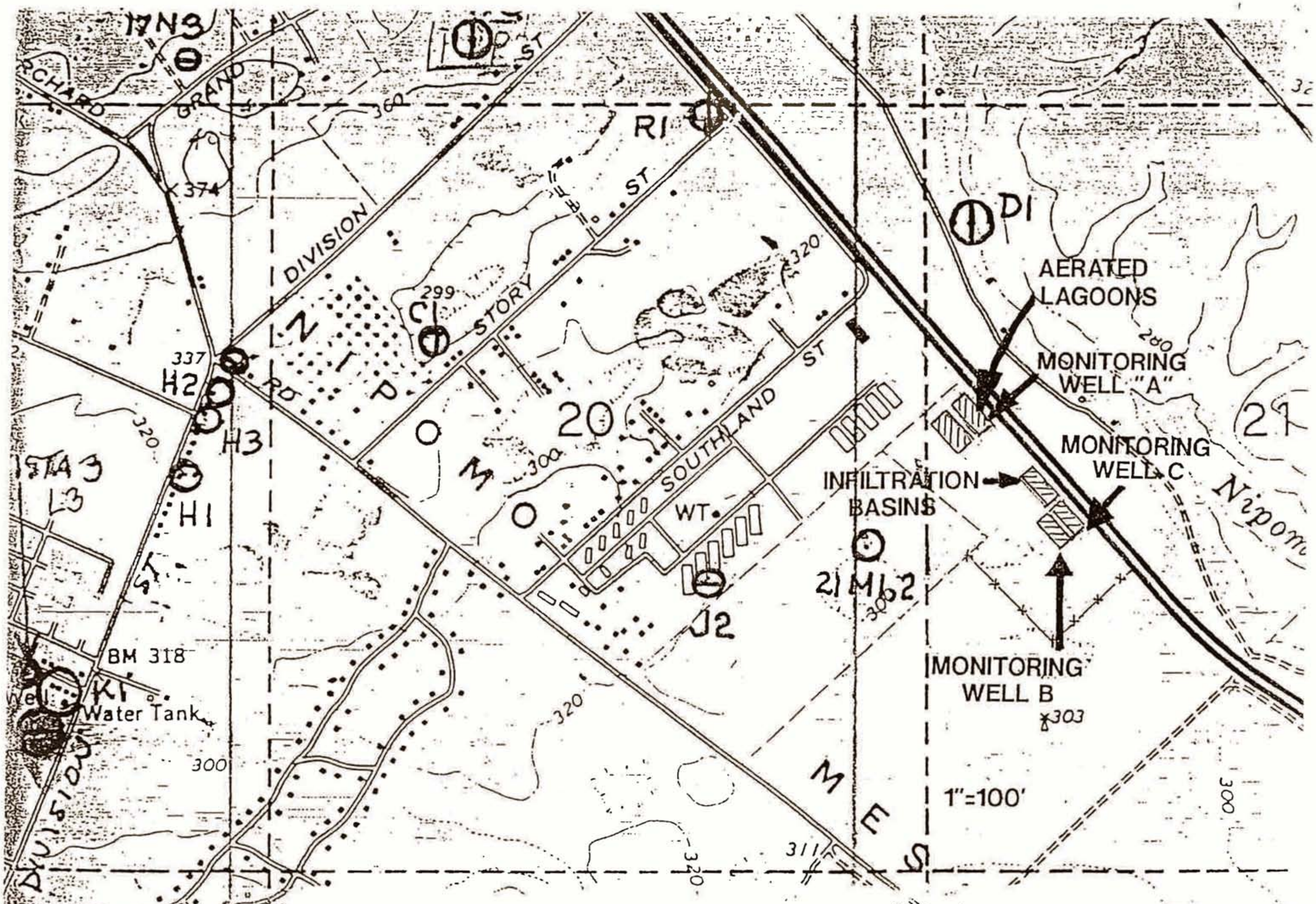


FIGURE II-1 NCSD WASTEWATER TREATMENT PLANT AND VICINITY constituent concentrations in underlying groundwaters be caused by the effluent discharge. Examples of relevant data reported in the August 1991 and August 1992 quarterly reports to RWQCB were as shown below:

| Water Quality Constit., mg/l | NCSDWWTP Effluent | Water Supply | Well A | Well B | Well C |
|---|---|---|---|---|---|
| TDS (7/18/91) | 1,100 | 350 | - | - | - |
| TDS (7/15/91) | - | - | 240 | 790 | 57 |
| TDS (7/9/92) | 1,100 | | 250 | 990 | 390 |
| $NO_3$ (7/11/91) | 35 | | | | |
| $NO_3$ (7/15/91) | - | 11 | 11 | 23 | 7.5 |
| $NO_3$ (7/16/92) | 35 | - | - | - | - |
| $NO_3$ (7/9/92) | - | | 11 | 23 | 7.5 |
| Cl (7/18/91) | 210 | 86 | - | - | - |
| Cl (7/15/91) | - | | 38 | 190 | 88 |
| Cl (7/9/92) | 180 | - | - | - | - |
| Cl (7/ | - | | 38 | 180 | 90 |

See later discussions concerning NCSD Credit for Effluent Recharge

* * * * *

TABLE III-1

HISTORICAL RAINFALL AT STA 001.0 AND STA 038.0 DURING DWR BASE PERIOD

| RAINFALL SEASON | STA 001.0 INCHES | DIV.BY 21.79 | CUM DEV. FR MN | STA 038.0 INCHES | DIV.BY 16.12 | CUM DEV. FR MN. |
|---|---|---|---|---|---|---|
| 1935-36 | 24.02 | 1.102340 | 0.102340 | 16.07 | 0.996898 | -0.00310 |
| -37 | 33.29 | 1.527765 | 0.630105 | 21.02 | 1.303970 | 0.300868 |
| -38 | 30.99 | 1.422212 | 1.052317 | 22.23 | 1.379032 | 0.679900 |
| -39 | 10.3 | 0.472693 | 0.525011 | 11.34 | 0.703473 | 0.383374 |
| -40 | 24.91 | 1.143184 | 0.668196 | 17.89 | 1.109801 | 0.493176 |
| 1940-41 | 42.92 | 1.969710 | 1.637907 | 31.09 | 1.928660 | 1.421836 |
| -42 | 23.61 | 1.083524 | 1.721431 | 18.86 | 1.169975 | 1.591811 |
| -43 | 26.06 | 1.195961 | 1.917393 | 18.28 | 1.133995 | 1.725806 |
| -44 | 22.44 | 1.029830 | 1.947223 | 13.57 | 0.841811 | 1.567617 |
| -45 | 21.28 | 0.976594 | 1.923818 | 14.58 | 0.904466 | 1.472084 |
| -46 | 17.99 | 0.825608 | 1.749426 | 11.35 | 0.704094 | 1.176178 |
| -47 | 14.27 | 0.654887 | 1.404313 | 11.23 | 0.696650 | 0.872828 |
| -48 | 15.54 | 0.713171 | 1.117485 | 11.55 | 0.716501 | 0.589330 |
| -49 | 14.05 | 0.644791 | 0.762276 | 12.09 | 0.75 | 0.339330 |
| -50 | 18.96 | 0.870123 | 0.632400 | 14.16 | 0.878411 | 0.217741 |
| 1950-51 | 15.61 | 0.716383 | 0.348783 | 11.48 | 0.712158 | -0.07009 |
| -52 | 29.3 | 1.344653 | 0.693437 | 23.59 | 1.463399 | 0.393300 |
| -53 | 16.83 | 0.772372 | 0.465810 | 13.65 | 0.846774 | 0.240074 |
| -54 | 19.77 | 0.907296 | 0.373106 | 15 | 0.930521 | 0.170595 |
| -55 | 17.28 | 0.793024 | 0.166131 | 14 | 0.868486 | 0.039081 |
| -56 | 25.16 | 1.154658 | 0.320789 | 18.37 | 1.139578 | 0.178660 |
| -57 | 15.98 | 0.733363 | 0.054153 | 11.27 | 0.699131 | -0.12220 |
| -58 | 34.55 | 1.585589 | 0.639743 | 26.77 | 1.660669 | 0.538461 |
| -59 | 11.76 | 0.539697 | 0.179440 | 10.18 | 0.631513 | 0.169975 |
| -60 | 15.91 | 0.730151 | -0.09040 | 16.16 | 1.002481 | 0.172456 |
| 1960-61 | 11.13 | 0.510784 | -0.57962 | 9.9 | 0.614143 | -0.21339 |
| -62 | 25.99 | 1.192748 | -0.38687 | 22.6 | 1.401985 | 0.188585 |
| -63 | 24.8 | 1.138136 | -0.24873 | 15.02 | 0.931761 | 0.120347 |
| -64 | 14.68 | 0.673703 | -0.57503 | 11.81 | 0.732630 | -0.14702 |
| -65 | 21.84 | 1.002294 | -0.57273 | 17.14 | 1.063275 | -0.08374 |
| -66 | 15.62 | 0.716842 | -0.85589 | 14.18 | 0.879652 | -0.20409 |
| -67 | 33.75 | 1.548875 | -0.30702 | 22.99 | 1.426178 | 0.222084 |

NOTES:

1. STA 001.0 IS CALPOLY GAGE. ITS RECORD BEGAN IN 1869-70.
2. STA 038.0 IS NIPOMO RAIN GAGE. ITS RECORD BEGAN 1920-21.

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## III - DATA ANALYSIS

This Section analyzes the data presented in Section II within the context of hydrogeologic. and potential water rights determinations.

### BASE PERIOD FOR SAFE YIELD ESTIMATION

As noted previously, DWR used a base period of 1935-36 through 1966-67 for the yield study Report of June 1979 (1). For convenience, the rainfall records of the SLOCFCWCD Rain Gages at Stas. 001.0 (CalPoly) and 038.0 (Nipomo) are repeated in Table III-1 for that period. It will be noted that the cumulative departures from long-term mean annual rainfall are generally similar for both rain gages.

Table II-2 has included a continuation of the display of annual rainfall for Stas 001.0 and 038.0 (among other stations). However, as noted previously, the rainfall experience in the years subsequent to 1966-67 has largely been above-normal, as indicated in the cumulative deviation from long-term mean rainfall for Sta 038.0 (Nipomo). Even so, the rainfall year 1966-67 marked the end of a series of dry years and the start of a period of above-normal precipitation, interrupted by an occasional dry year and, particularly by the sharp drought of 1976-77. The trend of above-normal rainfall continued until the recent drought, 1986-87 through 1990-91. The period 1966-67 through 1990-91 also included three exceptionally wet years (1969, 1978, and 1983).

Accordingly, the rainfall period of 1966-67 through 1990-91 is considered tentatively as an alternative base period to that used by DWR, 1935-36 through 1977-67, for the calculations of water balance and water yield. This latter period better coincides with the more recent land culture and pumpage data than the earlier period. Thus, both periods are considered herein.

### PUMPAGES

Pumpages were calculated for recent periods in Section II. These are repeated and expanded upon in Table III-2, including the pumpages employed by DWR in Table 11 of the June, 1979 Report (1).

TABLE III-2 - SUMMARY OF ESTIMATED PUMPAGES, NIPOMO MESA SUB-AREA
Pumpages are shown in acre-feet per year

| Calendar | Water Purveyor | | Private | Urban | Indus- | Irr. | Total |
|---|---|---|---|---|---|---|---|
| Year | Large | Small | Domestic | Supply | trial | Agr. | Pumpage |
| 1977+/- | - | - | - | 300 | 650 | 2,000 | 2,900 |
| 1980 | | | | | | | |
| 1985 | | | | | | | |
| 1986 | 1,600 | 270 | 850 | 2,720 | 1,320 | 2,450 | 6,490 |
| 1990 | 2,560 | 315 | 895 | 3,507 | 1,370 | 2,400 | 7,540 |
| 1992 | 2,553 | 333 | 910 | 3,796 | 1,370 | 2,136 | 7,302 |
| 1993 | 2,600 | 343 | 916 | 3,819 | 1,370 | 2,136 | 7,365 |
| 1995 | | 361 | 926 | | | | |

Notes of Table III-2:

(1) The 1977+/- data are from Table 11 in the DWR June 1979 Report (1). No breakdown was offered as to the components of the urban supply.

(2) The 1986 data are as shown in the LFM 1987 Report (3), showing a very large increase in pumpage from the values previously reported by DWR.

## GROUNDWATER LEVELS AND CONTOURS

In addition to hydrographs of several wells on NMSA, the DWR June 1979 Report (1) presented water level contours for AGGWB for both Fall, 1965 and Fall, 1975 conditions. (See Figures III-1 and III-2, reproducing DWR Figures 10 and 11, respectively.) In some locations on NMSA there was not much difference between the contours of Fall, 1965 and those of Fall, 1975, but in several localities, those of the later year were significantly lower than those of the earlier year.

## GROUNDWATER MOVEMENT

As the subsurface counterpart of normal land surface contours, the arrangements of well water contours indicate both the direction and potential speed of subsurface groundwater movement. Adjacent contours of different elevations, when grouped closely indicate a relatively rapid groundwater movement, while those spaced widely indicate the opposite. It is also possible for both ridges and mounds of subsurface water to occur, depending upon the complex, dynamic interactions of pumping and recharge of the various aquifers.

The DWR Report contours (Figures III-1 and III-2 herein) generally depicted subsurface flow in a northeast-southwest direction from Nipomo Valley (northeasterly of U.S. 101) across the Nipomo Mesa. However, the subsurface movement was seen to split, turning westerly from the Nipomo Mesa onto Cienega Valley and also towards the Pacific Ocean past the coastal dunes, while continuing southwesterly across the Santa Maria Valley. The DWR contours also suggested the existence of subsurface inflow to NMSA from the Nipomo Valley and hills northeasterly of NMSA. Additionally, the contours for both periods show the existence of "pumping holes" in the Central and West-Central Mesa. A pumping hole is a local depression within an otherwise normal pattern of groundwater levels. Water is drawn in from all directions into a pumping hole. The pumping holes of Fall, 1975 appear to be more well developed than those of Fall, 1965, implying increased local extractions in comparison with recharge.

Figures III-3, III-4, and III-5 present approximate groundwater contours on NMSA as determined by LFM for Fall conditions of 1975, 1985, and 1992, respectively. These contours were computer-produced, based upon well levels measured by SLOCED for the years depicted. Data from about 85 wells located in or near NMSA were considered, including all available data from wells actually on NMSA. The computer program "TERRA

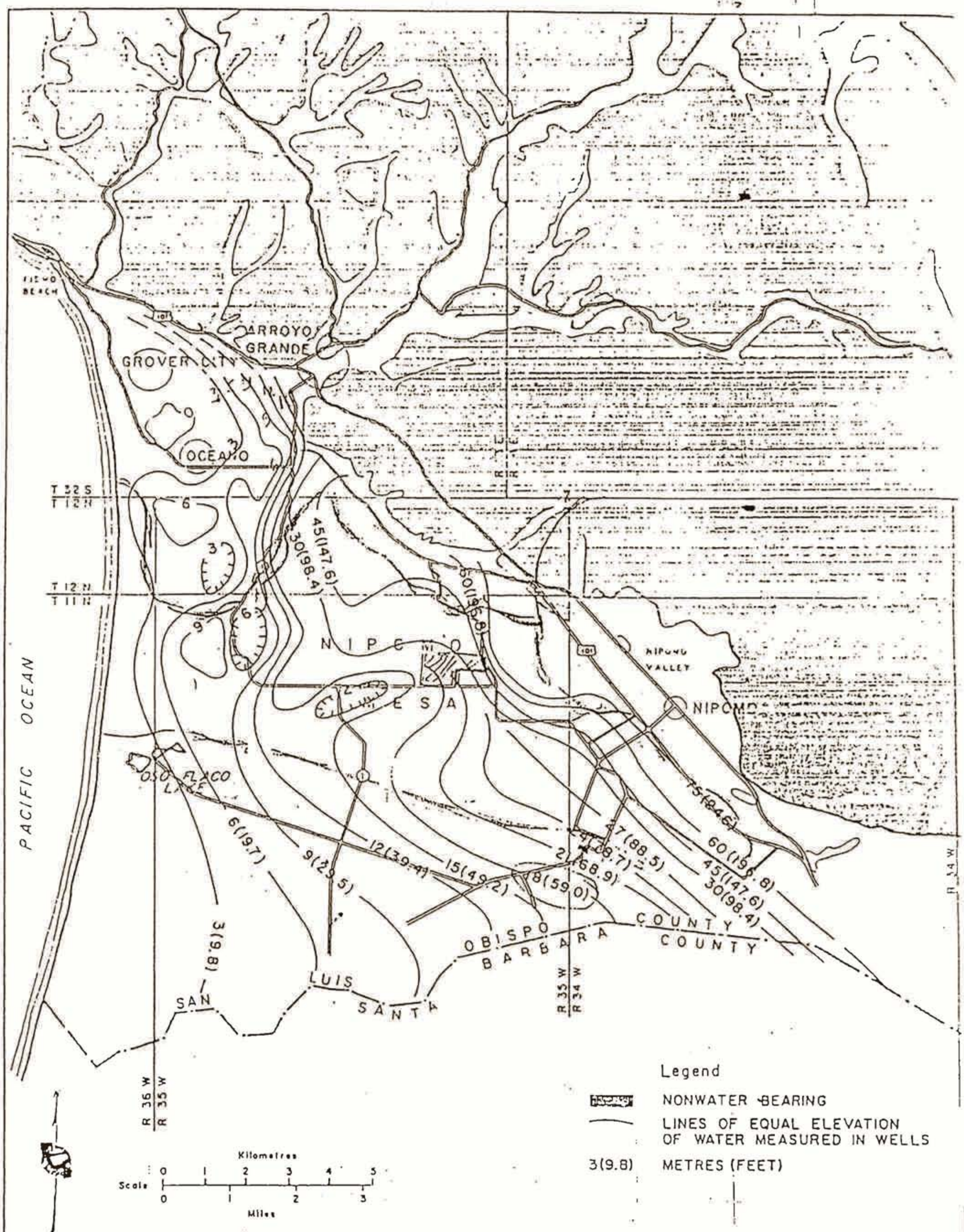


Figure 10 - WATER LEVELS, FALL 1965

DEPARTMENT OF WATER RESOURCES SOUTHERN DISTRICT

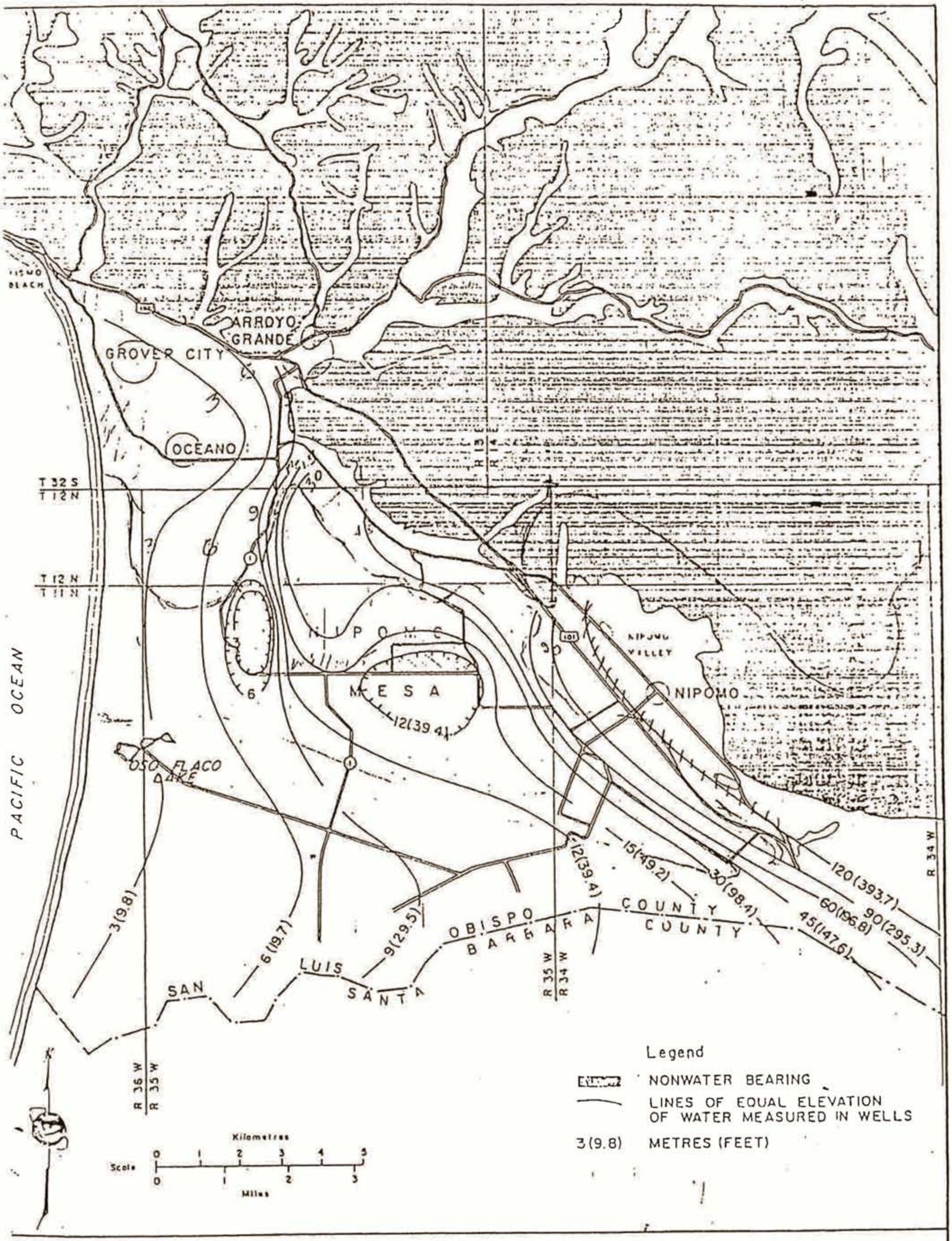


Figure II - WATER LEVELS, FALL 1975

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

MODEL" plots the digitized data as water level contours, using straight-time interpolation between data points. Under this arrangement, equal weight (importance) was given to each well for which data were available, and no attempt was made to distinguish between some wells which might be considered more representative of local conditions and those less representative. This procedure, which was used consistently for development of Figure III-3, III-4, and III-5, may differ somewhat from the DWR approach, thereby accounting for certain differences in results.

It should be mentioned that the omission of any well's data (as may be necessitated if the well was being pumped at the time of the survey or as may have been omitted for other reasons) has some effect upon the plotting of contours. However, normally such effects are only modest.

In comparing the pumping holes depicted in Figures III-3, III-4, and III-5 with those shown by DWR in Figure III-1 and III-2, it can be noted that there has been some apparent migration and/or expansion or contraction over the years. However, a new pumping hole may have developed in the south-central mesa area by Fall, 1992. This probably reflects increased pumping that has taken place in the last several years, particularly water purveyor pumping, as indicated in the previous section. Changes in pumping holes over the years undoubtedly reflect the dynamics of pumping and recharge.

An important aspect of subsurface groundwater movement is the indication of subsurface outflow from NMSA to adjacent sub-areas and to the offshore floor of the Pacific Ocean. The subsurface movement to adjacent sub-areas is approximated by considering gradients (downward slopes) of groundwater levels, (vertical) cross-sectional areas of saturated soils, and the characteristics of such soils to transmit subsurface flow (permeability). The subsurface flow rate is "laminar," being in direct proportion to the hydraulic slope, the typical cross-sectional area through which the groundwater is moving, and the permeability of the saturated soil.

Subsurface outflow to the Pacific Ocean is also approximated in the same manner as subsurface outflow to adjacent sub-areas. However, subsurface inflow from adjacent consolidated formations may sometimes be complicated by the possibility of basement rock contributing to the inflow by a vertical (as opposed to horizontal) movement. In all cases of subsurface flow calculations, the accuracy of the results is limited by the adequacy of the data being used and the validity of the assumptions employed.

Regarding subsurface outflow from NMSA, the original DWR Report showed 3,300 AFY total, but this was later amended (DWR letter of January 14, 1981 to C.H. Lawrance of JMM) as follows:

| Subsurface Outflow Direction to | Quantity AFY |
|---|---|
| Arroyo Grande Plain | 225 to 300 |
| Pacific Ocean | 225 to 350 |
| Santa Maria Valley | 2,300 to 2,800 |
| Total | 2,750 to 3,450 |
| **ROUND OFF** | **2,800 to 3,500** |

The LFM Report (3) assumed a mid-point value of 3,050 AFY to represent the total subsurface outflow from NMSA under 1987 conditions, divided between 260 AFY to the Pacific Ocean and 2,790 AFY to adjacent sub-areas. At that time, LFM did not attempt to differentiate between the estimated subsurface outflow to the Arroyo Grande Plain and that to the Santa Maria Valley. Because of varying groundwater levels and gradients, both with location and with time, it is difficult to estimate the subsurface movement of the groundwater other than in very rough fashion.

For example, a preliminary analysis was made in the LFM Report of subsurface flow conditions to and from NMSA for the Fall, 1975 groundwater level conditions shown by DWR. Consideration was given to cross-sectional areas, hydraulic gradients, aquifers penetrated and possible representative permeabilities of the saturated sediments. It was hoped to reconcile these several elements with the values calculated by DWR. It was found that no single permeability value could be used; rather, these had to be varied considerably, within a range of about 2 to 30 gallons per day per square foot (gpd/sq ft) in order to reconcile the approximate subsurface flow values suggested by DWR. Thus, the overall permeability assumed as being representative for an overall cross-section, such as from NMSA to Arroyo Grande Plain, would be limited by the existence of considerable quantities of clays and/or fine sands with low permeability values. In addition, the cross-sectional areas and water table hydraulic slopes were only roughly approximated.

The LFM approximations of subsurface groundwater movement for Fall, 1975 conditions are summarized in Table III-3 for illustrative purposes.

Table III-3

Approximation of Subsurface Groundwater Movement, Fall, 1975

| Subsurface Outflow to | Typical Cross-Section Depth | Length | Area | Hydr. Slope | Perm. gpd/sqft | Flow AFY |
|---|---|---|---|---|---|---|
| Arr.Grande | 450 | 7,100 | 3.2 | 0.038 | 2 | 270 |
| Pac. Ocean | 730 | 9,200 | 6.7 | 0.0021 | 17 | 270 |
| SMVall.(1) | 605 | 19,800 | 12 | 0.0014 | 30 | 560 |
| SMVall.(2) | 260 | 15,800 | 4.1 | 0.017 | 30 | 2,340 |
| Total Outflow, Approx. | | | | | | 3,440 |
| NMSA (Infl.) | 170 | 48,800 | 8.3 | 0.067 | 0.8 | 500 |

Notes:

(1) Data from Appendix A of LFM August 24, 1987 Report (3).

(2) Subsurface flows are approximated from NMSA to adjacent sub-areas (Arroyo Grande and Santa Maria Valley) and to the Pacific Ocean. Inflow also shown into NMSA from Nipomo Valley and beyond.

(3) Typical cross-section depths and lengths are shown in feet, area in millions of square feet.

(4) The annual subsurface flows are approximately as assumed in the groundwater balance in the LFM report, although the Santa Maria Valley numbers used are slightly lower than those calculated in the above table.

For Fall 1985, it appeared that the total subsurface outflow was roughly comparable to than that for Fall 1975. For Fall, 1992 many of the water level contours were somewhat lower than in Fall, 1985, so the total subsurface outflow was probably somewhat less than in either Fall, 1975 or Fall, 1985.

SUBSURFACE OCEAN OUTFLOW

Although subsurface outflow to the Pacific Ocean has not constituted a major component of the total subsurface outflow from NMSA, it is nevertheless the most important element of outflow. It is essential that coastal well water levels be maintained generally above sea level and that an average seaward gradient of the groundwater be maintained of sufficient magnitude to prevent, or at least delay, the freshwater: saltwater wedge(s) from moving into the freshwater aquifers underlying the Nipomo Mesa. These aspects have been discussed in the DWR June 1979 Report, the JMM Report, and the LFM Report.

As noted in the JMM Report, differences between freshwater and seawater densities show that for each 100 feet of ocean submergence of a freshwater aquifer discharging through the ocean floor, the coastal freshwater level must be about 2.5 feet above mean sea level to prevent landward movement of the seawater wedge. Where coastal freshwater levels are less than these theoretical values, it may be expected that the seawater will move in, seeking a balance.

The extent to which a wedge of seawater will extend shoreward from the ocean floor in a freshwater aquifer is directly proportional to the thickness of the aquifer and inversely proportional to the hydraulic gradient of the aquifer's freshwater discharge. In effect, because of aquifer dynamics, a "purging" effect of freshwater outflow must be maintained in order to "hold the seawater wedge at bay." The greater the freshwater outflow, the shorter is the length that the wedge extends landward, and vice versa.

From data presented in the DWR Report, LFM noted a hydraulic slope of about 0.21 percent for the coastal dunes areas under Fall, 1975 conditions. For Fall, 1985, LFM has estimated that the water level contours have altered but the general seaward gradient does not seem to be significantly different from that of Fall, 1975. The same is generally true of Fall, 1992. This implies no significant reduction in ocean outflow and no lengthening of the seawater wedge landward. It should be noted that the coastal monitoring well's levels (for 11N36W ) have continued to remain above sea level during the period of record. It is unfortunate that Well 11N36W is no longer measured, as this would improve the data base substantially.

SUBSURFACE OUTFLOW TO ADJACENT SUB-AREAS

In order to maintain a sufficient seaward gradient to retard significant landward movement of the saltwater wedge, there will automatically be a need for continuation of at least some "mounding in the central NMSA. Such conditions will automatically provide for continuing subsurface outflow to the adjacent Cienega Valley and Santa Maria Valley areas. However, the mounding may not necessarily be as substantial as has occurred in former years. The LFM 1987 Report suggested the possibility of a freshwater storage reduction above MSL within NMSA of about 50 percent as reducing the outflows to adjacent sub-areas by about 50 percent.

This arrangement could provide an opportunity for increased extractions locally in NMSA "at the expense" of reduced subsurface outflows to adjacent sub-areas (AGP-TCM and SMV) from NMSA. The total yield of the AGAGW will, of course, be unaffected, for only a single groundwater basin is involved. However, an increasing quantity of groundwater would be extractable from the NMSA and correspondingly decreased quantities of groundwater extractable from AGP-TCM and SMV.

## CHANGE OF STORAGE

For 1967 conditions, DWR estimated that the freshwater in storage above sea level in NMSA was some 194,000 AF, while in 1975, it had dropped to 172,000 AF. The LFM 1987 Report estimated that the storage had increased slightly, indicated to be by about 1,000 AF by the Fall, 1985, making the freshwater in storage above MSL still about 172,000 AF or probably 173,000 AF at the most. This estimate was based upon the so-called Theis Polygon Method in which storage changes within 16 polygon-shaped areas comprising NMSA were individually estimated, based on differences in water levels Fall, 1975 to Fall, 1985 in some 26 wells within these polygons. For the purposes of the LFM 1987 Report, the fresh water in storage above MSL in Fall, 1985 was taken as 172,000 AF.

It was appropriate to review this estimate in the current study. The number of wells was increased in hopes of improving the accuracy of this approach. Also, Fall well levels for 1965 and 1992 were considered, where available. The analysis pertaining to this update is summarized in Table III-4.

A separate approach toward estimating freshwater in storage above MSL was the contour method, using the computer program "Terra Model" to plot contours of ground water levels in the Fall of specified years as previously described. This was done for Fall conditions in 1975, 1985, and 1992, using all available data for wells in and in the vicinity of NMSA. The contours produced by Terra Model for these dates have been presented in Figures III-3, III-4, and III-5, respectively, and the computer model automatically calculates the quantity of freshwater in storage above sea level. Changes in storage are represented by the differences between the fresh water storage values for the respective periods.

As in the case of DWR's calculations, LFM also assumed an average specific yield of 14 percent of gross volumes above sea level to determine the available freshwater above mean sea level. It was estimated by LFM that these values were approximately as follows:

| Year | Storage, AF, Fall of Year | Change, AF |
|---|---|---|
| 1975 | 197,000 | - |
| 1985 | 200,000 | +3,000 |
| 1992 | 187,000 | -13,000 |

It will be noted that DWR's estimated freshwater in storage for Fall, 1975 was some 179,000 AF, so that LFM's Terra Model-calculated value was about 11 percent greater. However, when the same water level contours shown by DWR in the June 1979 report (1) were digitized into Terra Model, the calculated volume of freshwater in storage was identical to that shown by DWR. Thus, Terra Model is considered properly calibrated, and relative storage changes 1975-85 and 1985-92, using Terra Model-derived numbers are believed suitable for the analysis. It is

TABLE III-4 APPROXIMATION OF CHANGES IN GROUNDWATER STORAGE, NIPOMO MESA SUB-AREA, FALL CONDITIONS, USING THEIS POLYGON METHOD

| MESA AREA | ACREAGE | TOWNSHIP SECTION | FALL STANDING WATER LEVEL, FEET, MSL | | | | CHANGE OF ELEVATION IN FEET | | | | CHANGE OF STORAGE IN ACRE FEET | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REPRESENTED | OF AREA | & RANGE | 1965 | 1975 | 1985 | 1992 | 1965-75 | 1975-85 | 1985-92 | 1975-92 | 1975-85 | 1985-92 | 1975-92 |
| Northwest | 280 | 12N35W | 138.6 | 160.2 | 151.2 | - | +21.6 | -9.0 | - | - | | | |
| | | | - | - | 136.4 | - | - | - | - | - | -350 | - | - |
| | 450 | | - | 47.0 | - | 71.2 | - | - | - | +24.2 | - | - | +1,500 |
| | 450 | | - | 13.8 | 8.6 | 5.7 | - | -5.2 | -2.9 | -8.1 | -330 | -180 | -510 |
| N-Central | 1,000 | 12N35W | - | 57.7 | 49.4 | 39.5 | - | -8.3 | -9.9 | -18.2 | | | |
| | | | | - | 18.0 | 9.2 | - | - | -8.8 | - | | | |
| | | | - | 47.5 | 18.9 | 11.5 | - | -28.6 | -7.4 | -36.0 | -2,600 | -1,200 | -3,800 |
| | 325 | 12N35W | - | 215.9 | 186.8 | - | - | -29.1 | - | - | | | |
| | | | - | 198.3 | - | - | - | - | - | - | | | |
| | | | - | - | 156.1 | 154.3 | - | - | -1.8 | - | -2,200 | -140 | - |
| Northeast | 120 | 12N35W | - | 46.9 | 47.4 | 46.8 | - | +0.5 | -0.6 | -0.1 | Negl. | Negl. | Negl. |
| | 1,175 | 11N35W | - | 302.0 | 309.2 | 307.2 | - | +7.2 | -2.0 | +5.2 | +1,200 | -300 | -900 |
| | 120 | | | | | | | | | | | | |
| | | | - | 163.5 | 159.8 | 160.8 | - | -3.7 | +1.0 | -2.7 | -60 | +20 | -40 |
| | | 11N34W | - | 23.2 | 25.9 | - | - | +2.7 | - | - | | | |
| | | | - | 14.4 | 16.8 | - | - | -4.4 | - | - | | | |
| | | | - | - | 351.4 | 345.9 | - | - | -5.5 | - | | | |
| | | | - | 374.7 | - | 171.3 | - | - | - | 203.4 | - | - | - |
| E-Central | - | 11N34W | - | 319.7 | 294.9 | - | - | -24.8 | - | - | | | |
| | | | - | 298.0 | 270.5 | | - | -27.5 | | | | | |
| | | | - | 289.5 | 280.2 | 221.3 | - | -9.3 | -58.9 | -68.2 | | | |
| | 900 | | - | - | - | 223.0 | - | - | - | - | -1,200 | -7,400 | -8,600 |
| Southeast | 640 | 11N34W | - | 48.8 | 44.1 | 10.5 | - | -4.7 | -33.6 | -38.3 | -400 | -3,000 | -3,400 |
| | 650 | | - | 167.4 | 185.8 | 173.1 | - | +18.4 | -12.7 | - | | | |
| | | | - | - | 126.0 | 115.4 | - | - | -10.6 | - | | | - |
| | | | - | 160.5 | - | 158.3 | - | - | - | -2.2 | +1,700 | -1,100 | -200 |
| | 650 | | - | 61.4 | - | 16.0 | - | - | - | -45.4 | - | - | -4,100 |
| S-Central | | 11N35W | - | 24.6 | - | - | - | - | - | - | | | |
| | | | - | - | - | 26.5 | - | - | - | - | | | |
| | | | - | - | 55.0 | - | - | - | - | - | | | |
| S.M. Valley | 650 | 11N35W | - | - | 63.7 | 41.0 | - | - | -21.7 | - | | | |
| | | | - | - | - | 16.4 | - | - | - | - | - | - | - |
| S.M. Valley | 710 | 11N35W | - | 18.7 | 24.8 | 0.2 | - | +6.1 | -24.6 | -18.5 | +600 | -2,400 | -1,800 |
| Southwest | 570 | 11N35W | - | 15.9 | -2.0 | - | - | -17.9 | - | - | | | |
| | | | - | - | 24.8 | - | - | - | - | - | -1,400 | - | - |
| Coastal Dunes | 660 | 11N35W | - | 31.8 | 29.7 | - | - | -2.1 | - | - | -200 | - | - |
| | 4,550 | 11M36W | - | 8.2 | - | 5.9 | - | - | - | -2.3 | | | |
| | | | - | 17.1 | - | 5.8 | - | - | - | -11.3 | | | |
| | | | - | 12.5 | - | 9.6 | - | - | - | -2.9 | - | - | -3,500 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W–Central | 1,950 | – | 23.2 | 25.9 | – | – | +2.7 | – | – | | | |
| | | – | 14.4 | 16.8 | – | – | +2.4 | – | – | | | |
| | | −4.0 | −0.5 | – | – | +3.5 | – | – | – | | | |
| | | – | 11.0 | 2.1 | – | – | −8.9 | – | – | | | |
| | | – | – | 16.5 | – | – | – | – | – | | | |
| | | – | 25.4 | 25.8 | – | – | −0.4 | – | – | −300 | – | – |
| | | | 13.2 | | | | | | | | | |
| | | – | −12.2 | – | – | – | – | – | – | | | |
| W–Central | 3,140 | – | 50.9 | – | 16.1 | – | – | – | −34.8 | | | −15,300 |
| | | – | 32.8 | 20.8 | – | – | −12.8 | – | – | | | |
| | | – | – | – | 2.0 | – | – | – | – | −5,600 | – | |
| | | – | | | | | | | | | | |
| Central | 2,010 | – | – | 50.5 | – | – | – | – | – | | | |
| | | – | 99.0 | – | – | – | – | – | – | | | |
| | | – | – | 61.4 | 49.0 | – | – | −12.4 | – | | | |
| | | – | 64.8 | 67.2 | 76.3 | – | +2.4 | +9.1 | +11.5 | | | |
| | | – | 56.4 | 60.0 | 55.8 | – | +3.6 | −4.2 | −0.6 | +800 | −700 | +1,500 |
| Cienega Val. | – | 5.4 | – | 4.2 | 4.8 | – | – | +0.6 | – | | | |
| | | – | – | – | 26.4 | – | – | – | – | | | |
| | | – | – | 51.8 | 47.8 | – | – | −4.0 | – | | | |
| | | – | 59.9 | 57.5 | 54.1 | – | −2.4 | −3.4 | −5.8 | | | |
| | | – | 55.2 | 55.7 | 57.3 | – | +0.5 | −0.4 | +0.1 | – | – | – |

Total Acreage 21,000

| | | | |
|---|---|---|---|
| Approximate Storage Increase | +4,300 | +20 | +3,000 |
| Approximate Storage Decrease | −14,480 | −16,420 | −42,150 |
| Approximate Net Change | −10,380 | −16,400 | −39,150 |

Notes:

(1) This so–called "Theis zone of influence method" is a supplementary method for estimating freshwater storage change to that of the computer "Terra Model" using groundwater contours. In this Theis polygon method one or more wells are taken to be representative of the water levels within the area. The change in water level from one year to the next is assumed to be true throughout the acreage of the well's zone of influence. However, this assumption limits the accuracy of this approach. Also, for simplicity, LFM limited the numbers of polygons, so these are considerably fewer than the numbers of wells considered.

(2) The approximate acreage is listed next to the representative well or the first of a group of representative wells. The change in storage during a period is calculated from the change in the representative well's water level (or that of the average for a group of wells) based on acreage and 14 percent specific yield, following DWR's assessment of the water–bearing sediments. The volume change (rounded to the nearest 100 AF) is listed adjacent to the last well of the representative group.

(3) Because of gaps in the data, it is not possible to get complete numbers on storage change for all periods considered. The totals for storage increase, decrease, and net change aggregate the values tabulated. No numbers are listed in the storage change colunms even though changes of elevation were listed for a portion of the Northeast Mesa which is east of U.S. 101, for part of Santa Maria Valley, and for Cienega Valley, all of which lie outside of NMSA.

(4) The indications for storage change by this method were a significant decrease for 1975–85, which is opposite to what the computer's Terra Model determination of water level contours indicated. However, the overall 1975–92 storage change by the Theis Polygon method (even with data gaps) suggested a large reduction in storage, 1975–92, and this was also indicated by the contours. The contour results are considered more accurate than those in this table.

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recognized that the accuracy of the contours could be improved by additional data. Nevertheless, the contours appeared to be generally representative of groundwater conditions. See subsequent discussion concerning approximation of safe yield of NMSA.

## RETURN FLOWS

Return flows from M&I and agricultural pumpage, expressed as proportions of total pumpage, vary according to specific conditions. this includes the presence or absence of centralized sewerage facilities. Most of these have not changed since the LFM 1987 Report, but there are a few exceptions, as indicated in Table III-5.

TABLE III-5

APPROXIMATION OF RETURN WATER RATES FROM WATER USES IN NMSA

| Type of Water | Application or Rate | | Return or Return Rate | | |
|---|---|---|---|---|---|
| Application | 1987 | 1992 | 1987 | 1992 | (% appl. '92) |
| Quantity, AFY | | | | | |
| M&I Pumpage: | | | | | |
| Industrial | 1320 | 1,370 | 2 | 80 | (5.8) |
| NCSD, Sewered | 450 | 688 | 129 | 197 | (28.6) |
| NCSD, Unsew. | 800 | 763 | 62 | 134 | (17.6) |
| Other Sewr'd | - | - | 17 | 17 | - |
| CCW, Sewered | 696 | 1,102 | 231 | 366 | (33.2) |
| Small Purv. | 270 | 333 | ( | ( | |
| Priv. Pump. | 850 | 900 | (532 | (586 | (47.5) |
| Rate, AFY/ac | | | | | |
| Black Lake Golf | 3.1 | 3.1 | 0.15 | 0.15 | 5 |
| Other Landscape | 3.3 | 3.3 | 0 | 0 | - |
| Irrig. Agric. | | | | | |
| Pasture | 3.3 | 3.3 | 0 | 0 | - |
| Veg .& Nurs. | 2.0 | 0 | 0 | 0 | - |
| Deciduous | 2.6 | 2.6 | 0 | 0 | - |
| Citr./Subtrp. | 2.0 | 2.0 | 0.4 | 0.4 | 20 |

## DEEP PERCOLATION OF RAINFALL

This element has been elusive in the past. It was estimated by DWR in the June 1979 Report as being equivalent to only 0.156 ft/yr (3,300 AFY on 21,100 acres of NMSA). However, The Morro Group (4) challenged this figure, based upon considerations of hydrogeology, and asserted that it should be at least double that suggested by DWR. The LFM 1987 Report (3) accepted the DWR number as being the best figure then available but increased it slightly to reflect the recharge augmentation expected from a modest expansion in irrigated agricultural acreage which had been experienced since the time of the DWR report.

The deep percolation of rainfall is one of several unmetered elements in the water budget for NMSA. For this current investigation, LFM deems it appropriate to estimate the element of deep percolation of rainfall parametrically as one part of the overall balance of aquifer inflows and outflows for NMSA, as explained below.

## APPROXIMATION OF SAFE YIELD OF NMSA

The safe yield (dependable yield) of a groundwater element such as NMSA is probably best estimated by investigation of the elements of supply and disposal that affect the aquifer(s). This was the approach taken by DWR in the June 1979 Report. The objective is to select a period of time when land culture and pumping conditions are fairly constant and rainfall is generally representative of long-term mean conditions. This should provide a balance of supply and demand. In the case of NMSA, surplus recharge leaves as subsurface outflow to the adjoining sub-areas, under the groundwater dynamics. However, there are several variables for which assumptions must be made, and the DWR assumptions regarding deep percolation of rainfall have recently been challenged. Thus, LFM has explored the safe yield results obtainable under differing assumptions for this variable.

Table III-6 presents a parametric estimation of safe yield of Nipomo Mesa Sub-Area of Arroyo Grande Area Groundwater Basin. Input data for the calculations include measured quantities where possible and the best estimates of such quantities which are not measured or otherwise amenable to calculation.. In the matter of deep percolation of rainfall, a parametric approach is used by arbitrarily assuming varying values in succession and rating the resulting calculations of water balance for plausibility. A secondary parametric variable chosen is that of subsurface outflow. Although this element has not been challenged recently, it is of considerable interest and consequence. Thus, it was considered suitable for reexamination in this context, even while recognizing that it is probably incapable of being estimated accurately.

The results of the parametric estimation are as follows:

1. The increase in storage 1975-85 (a period of above-average rainfall) was compatible with a presumed deep percolation of rainfall rate of about 2 times the DWR value and the basic DWR value for subsurface outflow.

2. The apparent major drop in storage 1985-92 was also generally compatible with the scenario combination of 2 times the DWR value for deep percolation of rainfall and the basin DWR subsurface outflow value.

3. Based upon the data in hand and analysis thereof, it tentatively appears that the rainfall deep percolation should be about double that used by DWR, that the dependable yield of NMSA may be in the order of 8,000 AFY currently (based upon pumpage), and that the current overpumpage is in the order of 1,200 AFY.

TABLE III–6 – PARAMETRIC ESTIMATION OF SAFE YIELD OF NIPOMO MESA SUB–AREA OF ARROYO GRANDE AREA GROUNDWATER BASIN

| WATER SUPPLY OR | WATER SUPPLY ITEMS | | | WATER DISPOSAL ITEMS | | | SUPPLY MINUS DISPOSAL | | | FRESHWATER ABOVE MSL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISPOSAL ITEM | 1975 | 1985 | 1992 | 1975 | 1985 | 1992 | 1975 | 1985 | 1992 | 1975 | 1985 | 1992 |
| WATER SUPPLY, AFY | | | | | | | | | | | | |
| Deep Perc. Rain: | | | | | | | | | | | | |
| 1A Basic DWR | 3,300 | 3,510 | 3,515 | | | | | | | | | |
| 1B 1.5 x DWR | 4,950 | 5,265 | 5,273 | | | | | | | | | |
| 1C 2.0 x DWR | 6,600 | 7,020 | 7,030 | | | | | | | | | |
| 1D 2.5 x DWR | 8,250 | 8,775 | 8,789 | | | | | | | | | |
| Subsurface Inflow | 500 | 500 | 500 | | | | | | | | | |
| Pumpage Returns: | | | | | | | | | | | | |
| Industrial | N/S | 2 | 81 | | | | | | | | | |
| NCSD, Sewered | N/A | 140 | 197 | | | | | | | | | |
| NCSD, Unsewered | N/S | 62 | 134 | | | | | | | | | |
| CCW System | N/S | 231 | 366 | | | | | | | | | |
| Small Purveyors | N/S | 128 | 158 | | | | | | | | | |
| Private Wells | N/S | 404 | 428 | | | | | | | | | |
| Subtotal, Urban | N/S | 967 | 1,364 | | | | | | | | | |
| Black Lake Golf | N/S | 17 | 17 | | | | | | | | | |
| Agric.Irr. Returns | | | | | | | | | | | | |
| Pasture | N/S | 0 | 0 | | | | | | | | | |
| Veg. & Nurseries | N/S | 0 | 0 | | | | | | | | | |
| Greenhouses | N/S | – | 0 | | | | | | | | | |
| Deciduous | N/S | 0 | 0 | | | | | | | | | |
| Citr./Subtropical | N/S | 224 | 368 | | | | | | | | | |
| Other | N/S | – | – | | | | | | | | | |
| Subtotal,Irr.Ret. | N/S | 241 | 385 | | | | | | | | | |
| Total Urb/Irr.Ret. | 1,000 | 1,208 | 1,749 | | | | | | | | | |
| Total Supply, 1A | 4,800 | 5,218 | 5,264 | | | | | | | | | |
| Total Supply, 1B | 6,450 | 6,973 | 7,022 | | | | | | | | | |
| Total Supply, 1C | 8,100 | 8,228 | 8,779 | | | | | | | | | |
| Total Supply, ID | 9,750 | 9,983 | 9,867 | | | | | | | | | |
| WATER DISPOSAL, AFY | | | | | | | | | | | | |
| Subsurf. Outflow | | | | | | | | | | | | |
| S1 Basic DWR | | | | 3,050 | 3,050 | 3,050 | | | | | | |
| S2 0.5 x DWR | | | | 1,525 | 1,525 | 1,525 | | | | | | |
| S3 1.5 x DWR | | | | 4,575 | 4,575 | 4,575 | | | | | | |
| Pumpage Item | | | | | | | | | | | | |
| Industrial | | | | 650 | 1,320 | 1,370 | | | | | | |
| NCSD, Sewered | | | | – | 450 | 688 | | | | | | |
| NCSD, Unsewered | | | | N/S | 350 | 763 | | | | | | |
| CCW System | | | | N/S | 696 | 1,102 | | | | | | |
| Small Purveyors | | | | N/S | 270 | 333 | | | | | | |
| Private Wells | | | | N/S | 850 | 900 | | | | | | |
| Subtot. Urb. Pump. | | | | 950 | 3,936 | 5,156 | | | | | | |
| Black Lake Golf | | | | N/S | 357 | 357 | | | | | | |
| Pasture | | | | N/S | 303 | 56 | | | | | | |
| Veg. & Nurseries | | | | N/S | 660 | 790 | | | | | | |
| Greenhouses | | | | N/S | Incl. | Incl. | | | | | | |
| Deciduous | | | | N/S | 13 | 13 | | | | | | |
| Citr./Subtropical | | | | N/S | 1,120 | 920 | | | | | | |
| Other | | | | N/S | – | – | | | | | | |
| Subtot. Irrigation | | | | 2,000 | 2,453 | 2,136 | | | | | | |
| Tot.Urb/Irr.Pumpage | | | | 2,950 | 6,389 | 7,292 | | | | | | |
| Total Disposal, S1 | | | | 6,000 | 9,439 | 10,340 | | | | | | |
| Total Disposal, S2 | | | | 4,475 | 7,914 | 8,815 | | | | | | |
| Total Disposal, S3 | | | | 7,525 | 10,964 | 11,865 | | | | | | |
| WATER BAL. COMB'N., PARAMETRIC, AFY | | | | | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1A & S1 | (1,200) | (4,221) | (5,076) | 197,000 | 200,000 | 187,000 |
| 1A & S2 | 325 | (2,696) | (3,551) | 197,000 | 200,000 | 187,000 |
| 1A & S3 | (2,725) | (5,746) | (6,601) | 197,000 | 200,000 | 187,000 |
| 1B & S1 | 450 | (2,466) | (3,318) | 197,000 | 200,000 | 187,000 |
| 1B & S2 | 1,975 | ( 941) | (1,793) | 197,000 | 200,000 | 187,000 |
| 1B & S3 | (1,075) | (3,991) | (4,843) | 197,000 | 200,000 | 187,000 |
| 1C & S1 | 2,100 | (1,211) | (1,561) | 197,000 | 200,000 | 187,000 |
| 1C & S2 | 3,625 | 314 | ( 36) | 197,000 | 200,000 | 187,000 |
| 1C & S3 | 575 | (2,736) | (3,086) | 197,000 | 200,000 | 187,000 |
| 1D & S1 | 3,750 | 544 | ( 473) | 197,000 | 200,000 | 187,000 |

NOTES:

(1) The deep percolation recharge values used by DWR(1) in their appraisal of total supply for Nipomo Mesa Sub–Area (NMSA) have been questioned as being too low(4). Inasmuch as this important recharge element is not currently quantifiable, LFM has elected to explore the effects parametrically of different magnitudes of rainfall recharge corresponding to 1A (basic DWR value), 1B (1.5 x DWR value), 1C (2.0 x DWR value), and ID (2.5 x DWR value).

(2) Another element warranting reconsideration is that of subsurface outflow from NMSA to the Pacific Ocean and to adjoining sub–areas. The parametric estimation considers the basic DWR value (S1), one–half the DWR value (S2), and 1.5 x DWR value (S3).

(3) The rainfall during the Period 1975–85 was about 19 percent above long–term mean, while that during the period 1985–92 was nearly 9 percent below long–term mean. Under a theoretical balance of supply and disposal (other than rainfall), storage should have increased during 1975–85 and decreased under 1985–92 conditions. Using storage values calculated by Terra Model, storage actually appeared to increase an average of about 300 AFY under the earlier period and to decrease in an approximate average rate of nearly 1,900 AFY for the later period, thus indicating greater supply than disposal for the earlier period and the reverse for the later one.

(4) The best combination of parametric assumptions pertaining to rainfall recharge and subsurface outflow for 1975–85 appears to be ICS2, corresponding to 2 x the DWR rainfall recharge and 1.0 x the DWR subsurface outflow. This combination suggests a theoretical gain of nearly 1,940 AFY, 1975–85, using average values for both supply and disposal for this period. The actual gain in storage averaged about 1,500 AFY, 1975–85, even with above–average rainfall.

(5) For the period 1985–92, the increased disposal, largely as a result of increased urban pumpage, combined with below–average rainfall has apparently caused a significant decrease in storage, perhaps nearly 3,600 AFY average, if the storage data are correct. However, Scenario 1CS2 would indicate a gain of 2,135, but Scenario 1CS1 would indicate a loss of 1,390 AFY. Scenario 1CS3 would indicate loss of over 2,900 AFY, 1985–92.

(6) This parametric analysis indicates that the rainfall recharge element should be about that used originally by DWR, i.e. corresponding to supply Scenario 1C. The disposal element related to subsurface outflow is suggested to vary between greater than DWR's value for 1975–85 (i.e. S2) and less than DWR's value for 1985–92 (i.e. S3).

(7) This parametric analysis indicates that the dependable yield of NMSA may be in the order of 8,000 AFY, based upon pumpage and under recently prevailing conditions for subsurface outflow to the Pacific Ocean and neighboring sub–areas. However, there appears to be an overpumpage in the order of 1,200 AFY, under long–term rainfall conditions and even allowing for a greater rainfall recharge to NMSA than previously estimated by DWR.

(8) The data limitations restrict the accuracy of the estimates. All supply, disposal, yield, and deficit numbers be considered as approximate.

(9) Various assumed items in the hydrologic equation could also be re–examined, such as subsurface inflow, subsurface outflows, and returns from both urban and agricultural pumpage. These are difficult to quantify. However, their values influence the overall results of the hydrologic balance.

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It should be noted that an approach often used in groundwater safe yield investigations involves determining representative annual pumpage over a period of base period of rainfall and calculating the storage change from beginning to end of period. This approach is very practical as long as the pumpage, land culture, and water (and/or sewage) importation and exportation are actually fairly constant, for it then precludes the need to estimate the immeasurable items of subsurface inflow and outflow and deep percolation of rainfall. Unfortunately, changing conditions of pumpage and land culture on NMSA have reduced the attractiveness of this method. Also, the 1975-92 period is not as long as is desirable for a hydrologic base period. Thus, the results of the foregoing analyses must be considered as tentative and subject to refinement.

## DISCUSSION OF METHODOLOGY

This study's methodology parallels that of other investigators in many respects but differs in certain other respects. These latter involve a parametric study of certain supply and disposal items as well as computer calculations using all available water levels in estimating freshwater in storage at a given point in time.

### PARAMETRIC ANALYSIS

A key aspect of the study was the determination of yield of NMSA but this, in turn, hinged upon a major element of water supply to the groundwater, that of deep penetration of rainfall. This element is not directly measurable but must be inferred from other measurements and calculations. Accordingly, most previous consultant studies have relied upon the assessment of this factor made by the State of California, Department of Water Resources (DWR) in their June, 1979 Report (1).

A recent challenge of the DWR-adopted rainfall recharge value was made by a hydrogeologist consultant, asserting that this value was too low to fit the local circumstances on NMSA and should be at least twice as much as DWR had used. Because this element of groundwater recharge is very significant in determining overall groundwater yield, it was important that this issue should be addressed.

LFM elected to address the matter on the basis of a parametric analysis, whereby the known elements of the hydrologic equation (supply and disposal) were calculated and then various trial values of the rainfall recharge were included to see which assumption appeared best to fit the changes in groundwater storage that had occurred over periods of time. The trials or Scenarios, included the original or "basic" DWR value (Scenario 1A), 1.5xDWR Value (Scenario 1B), 2.0xDWR Value (Scenario 1C), and even 2.5xDWR Value (Scenario 1D).

Concurrently, the parametric analysis included consideration of subsurface outflow, another elusive element in the hydrologic equation. For purposes of the analysis, the trial values included the original or "basic" DWR Value (Scenarios 1), 0.5xDWR Value (Scenario S2), and

1.5xDWR Value (Scenario S3). Thus, the combination Scenarios considered were 1A&S1, 1A&S2, 1A&S3, 1B&S1, etc. These have been displayed in Table III-6, whose footnotes explain the procedures used.

Of all the Scenarios considered, Scenario 1C&S1 appeared to LFM to yield results in average increase or decrease in water balance for the two successive periods studied (1975-85 and 1985-92, respectively) which best fitted the average annual changes in storage calculated for these periods. On this basis, LFM estimated that rainfall recharge to NMSA should be about double the value originally used by DWR. However, the analysis indicated that the basic DWR value for subsurface outflow should probably be continued in use, even while recognizing that this value cannot actually be measured and must necessarily be inferred.

For purposes of this report, Scenario 1C&S1 has been utilized by LFM in the various calculations of yield and overdraft. Despite this increase in probable recharge by deep penetration of rainfall to the underlying aquifer(s) from that DWR value, there still appeared to be a moderate local overdraft of groundwater from NMSA.

WELL LEVELS COMPUTED BY TERRAMODEL

As described previously, this computer model calculates water level contours based upon the levels of wells which have been digitized on the map of NMSA. It also calculates freshwater in storage, thereby enabling average changes in storage to be computed and related to excesses or deficiencies in supply.

The accuracy of the water level contours, computed freshwater in storage, and computed storage changes is enhanced by providing the maximum numbers of well levels as computer input. Accordingly, LFM has consistently sought to use as much valid well level data as possible for the three measurement periods (Fall of 1975, 1985, and 1992, respectively). The results obtained are considered to be reasonable and the method preferable to one which would limit the numbers of wells providing data.

## NCSD CREDIT FOR EFFLUENT RECHARGE

As indicated in Section II, NCSD has collected wastewater through its centralized system and disposed of treatment plant through the NCSDWWTP in generally increasing quantities since 1989. Some of the water supply from which the wastewater originated was pumped from wells in the Nipomo Valley and outside the NMSA; however, most of the well pumpage occurred within the NMSA. In either case, NCSD took custody of the wastewater, treated it, and released the treated wastewater for percolation and recharge of NMSA. As such, NCSD should be credited for this recharge in consideration of its pumpages.

The metered or estimated wastewater flows into the NCSDWWTP have indicated the following values in recent years:

| Calendar Year | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|
| Wastewater flow, AFY | 150 | 175 | 205 | 196 | 197 |

The total five-year wastewater delivery is about 823 AF. The total surface area of the five wastewater ponds is approximately 5.5 acres. The first two ponds are aerated and expose about 2.6 acres; the final three ponds infiltrate the effluent and involve about 2.8 acres.

The normal evaporation rate from pond water surfaces in this area is about 3.6 ft/yr and the long-term average rainfall is 16.02 in/yr (1.34 ft/yr). Thus, the net loss by evaporation from the ponds would be about 2.3 ft/yr. Thus, the evaporation losses would average about (5.5) (2.3) = 13 AFY. In effect, the aggregate percolation during the past 5 years cited would be: 823 - 5 (13) = 760 AF.

The effluent percolation has had a noticeable effect both upon groundwater levels and groundwater quality in the immediate vicinity of the percolation ponds, particularly in Wells "B" and "C". Well "B" is known as Percolation Pond Monitor #2 (see Figure II-1) and is located within a few feet of the southeast corner of the effluent percolation ponds and about 400 feet southwesterly of Well "C", known as Percolation Pond Monitor #1 and adjacent to the northeast corner of these ponds. Both Monitors #1 and #2 are located about 2,000 ft southeasterly of Well "A", also known as the Pre-discharge Monitoring Well.

A review of NCSD monitoring well data submitted to RWQCB for 1991-93 indicates that only Well "B" reflects plant effluent quality, particularly in the constituents of Total Dissolved Solids (TDS), sodium (Na), Chloride (cl), sulfate ($SO_4$), and nitrate ($NO_3$). Additionally, Well "B" shows a modest "mounding" of groundwater, the estimated ground water elevation of Well "B" being 11 feet higher than that of Well "A" on April 23, 1993. Normally, there would be little significant differences between water levels for these two wells.

Even more striking is the mounding experienced at Well "C", for which the ground water level on April 23, 1993 was 63 ft higher than that of Well "A" and 74 ft higher than that of Well "C". Well "C" has a depth of 220 ft and encounters grey, hard sandstone shale at 190 ft depth. The top 80 ft of strata are coarse or packed red sand, after which various clays are encountered. Thus, it appears that the April 23, 1993 well water depth was below the sands and within the clays.

* * * * *

## IV - APPORTIONMENT OF SAFE YIELD

It was indicated in Table III-4 that the safe yield (dependable yield) of NMSA is probably about 8,000 AFY, *based upon pumpage and current (1992) conditions of subsurface outflow to the Pacific Ocean and to adjacent sub-areas of the groundwater basin*. It was also noted that there appeared to be an overpumpage currently in the order of 1,200 AFY, assuming that the recharge from deep percolation of rainfall was about 200 percent of the value previously estimated by DWR in their June 1979 Report (1).

It was previously stressed in the LFM 1987 Report (3) that the NMSA safe yield is a function of subsurface outflow, for a substantial portion of the natural recharge to NMSA replenishes Santa Maria Valley Sub-Area and a lesser amount replenishes Cienega Valley portion of the AGP-TCM Sub-Area. (The subsurface outflow to the Pacific Ocean is also an outflow component, but it must be sustained in order to avoid the disastrous consequences of seawater intrusion.) The LFM Report noted that if the subsurface outflow to adjacent basins were to be reduced, the quantity of supply available for local pumpage on NMSA would increase. In fact, increased local pumpage would tend to lower groundwater levels within NMSA, thereby reducing the gradients for subsurface outflow. The LFM Report presented several illustrative scenarios for water demands, presence or absence of imported water supply, and assumed adjustments of the subsurface outflows to adjacent sub-areas. These latter were taken as 100 percent and 50 percent, respectively of current subsurface outflow, and the corresponding quantity of freshwater in storage was taken as taken 100 percent of current and about 50 percent of current.

The illustrative scenarios of the LFM 1987 Report estimated that the annual loss in storage under then-current conditions was some 4,200 AFY (based upon the analyses made at that time) but that if the basin were to be drawn down so that the quantity of freshwater in storage above MSL were about 50 percent of current, the loss in storage would be reduced to about 2,800 AFY. The adjustment would be the result of reduced subsurface outflow to adjacent sub-areas. The details and complexities of specific pumpages by various parties, the impacts of such pumpages, and the rights of the parties to pump were not included within the scope of that investigation. However, it was commented that as far as sub-area drawdown was concerned, the matter of water rights did not appear to be an issue with pumpers in adjoining sub-areas. That was because there would generally be a continuation of the exercise of overlying rights by the various pumpers on the NMSA plus certain appropriations by the various domestic water systems. The large and small public water supplies on the Nipomo Mesa were essentially confining their deliveries to properties on the Mesa.

The 1987 LFM report also noted that significant quantities of water pumped from NMSA by NCSD had previously been exported to the Town of Nipomo (which lies outside NMSA) to supplement pumpage from local NCSD wells within Nipomo, with essentially complete consumptive loss from NMSA of such exported pumpage. However, beginning in 1987, a reversal of this process had commenced as the result of completion and activation of the centralized system of sanitary sewers. Thus, not only did a component of water originating in NMSA return as sanitary sewage to the new NCSDWWTP but also some of the pumpage originating in the local wells within the Town of Nipomo returned in the wastewater flow. Such wastewater, of course, is used to replenish NMSA, following treatment. These matters are now of significance to this current report.

The above water supply facets all have a bearing upon water rights in the NMSA, and it may be useful to consider the apportionment of safe yield in more than one manner, as explained below, wherein the matters of overlying and prescriptive rights are not considered but only the aspects of pumpages and returns to the NMSA.

Based Upon Current NMSA Conditions

Under the assumptions stated above a theoretical allocation of pumpage rights, *under current (1992) conditions* would be calculated approximately as follows:

| Entity | Gross AFY | Pumpage % Total | Net Returns to NMSA, AFY | Consumptive Use AFY | Consumptive Use % Total |
|---|---|---|---|---|---|
| NCSD | 1,451 | 19.9 | 331 | 1,120 | 20.2 |
| CCW | 1,102 | 15.1 | 366 | 736 | 13.3 |
| Small Purv. | 333 | 4.6 | 158 | 175 | 3.1 |
| Private Wells | 900 | 12.3 | 428 | 472 | 8.5 |
| Industrial | 1,370 | 18.8 | 81 | 1,289 | 23.3 |
| Black Lake Golf | 357 | 4.9 | 17 | 340 | 6.1 |
| Irrig. Agricult. | 1,779 | 24.9 | 368 | 1,411 | 25.5 |
| Total | 7,292 | 100.0 | 1,749 | 5,543 | 100.0 |

Under current conditions, it is estimated that the safe yield of the NMSA for pumpage is about 8,000 AFY. However, this is premised upon the returns that have been supposed as well as the substantial subsurface outflows corresponding to "S1 Basic DWR", i.e. 3,050 AFY. The natural replenishment supposed was "1C 2.0 x DWR", i.e. 7,030 AFY deep percolation from rainfall plus 500 AFY subsurface inflow, for a combined total of 7,530 AFY. From this is deducted the subsurface outflow, "normally" calculated (by DWR) as about, 3,050 AFY, leaving 4,480 AFY. This is the approximate safe yield for *consumptive use* of NMSA.

As NCSD increases its wastewater management system utilization and the recharge of the NMSA with percolated effluent, NCSD's allocated share of the basin consumptive use yield will theoretically *decrease* correspondingly. However, this is not in accordance with established water rights matters; on the contrary, the recovery of water for beneficial use by replenishment may be taken as a right to such water, analogous to that of a public agency replenishing a groundwater basin via injection wells or other means.

**Based Upon Reduced Subsurface Outflow**

If the subsurface outflow to adjacent sub-areas were to be reduced so that the total subsurface outflow, including the (undiminished) subsurface outflow to the Pacific Ocean, were approximately 50 percent of current estimated values, there would theoretically be an increase in the safe yield of NMSA for consumptive use of 1,525 AFY. The total natural replenishment would then be calculated as:

4,480 + 1,525 = 6,005 AFY - safe yield for consumptive use.

NCSD's current share of this total value would be:

0.202 x 6,005 = 1,213 AFY for consumptive use.

**Aspects of Water Main Leakage**

The total water production of a water purveyor usually exceeds the metered deliveries of the purveyor for the same period of time. Part of this may be due to unmetered water usage (fire fighting, street flushing, etc.), part due to metering inaccuracies, and part due to actual leakage from water mains and service connections. No evaluation has been made of these aspects in this current study, although main leakage addressed to some extent in the LFM 1987 Report (3). The recharge to the NMSA from water main and service connection leakage is probably modest in magnitude, and it did not seem worthwhile to consider it in detail, especially in view of the uncertainty regarding replenishment by deep percolation of rainfall, which is of much greater importance. This matter can be examined subsequently if warranted.

* * * * *

## V - CONCLUSIONS AND RECOMMENDATIONS

This study has been intended to update the preceding engineering investigations on groundwater yields and rights on the Nipomo Mesa on behalf of the interests of NCSD. It is implicit that all work presented herein has been performed in an objective manner, based entirely upon factual data and other material.

### CONCLUSIONS

1. Satisfactory data were available concerning land use, populations, and pumpages from the various municipal, industrial, rural residential, and agricultural categories, to enable LFM to estimate current pumpages. This was despite the fact that no land use survey had been performed since 1984. (It is understood that the next DWR land use survey will not be scheduled until much later in 1993 or in 1994, at the earliest.)

2. Analysis of water level data obtained from San Luis Obispo County Engineering Department (SLOCED) for numerous wells on or near NMSA indicated that the storage of freshwater above Mean Sea Level (MSL) within NMSA had increased somewhat during the period 1975-85 but had subsequently decreased even more substantially during the ensuing period 1985-92 that was considered. The accuracy of the analysis was somewhat limited by the data availability, for occasionally well water levels could not be measured because the wells were being pumped. Also, there were occasions when the levels for some wells were not included in the semi-annual surveys by SLOCED. In addition, not all parts of NMSA have representative wells available for measurement. Expansion of the data base to include 1993 conditions, might improve the representative nature of the groundwater conditions. It is also possible that a future detailed analysis of well logs, pumpages, and well levels might provide an improved means of estimating storage changes over that used herein (the Terra Model input included available data on as many wells as possible rather than a limited number of "index" wells). For now, however, LFM adheres to the method used as being the most accurate.

3. No universally accepted value exists for the magnitude of natural recharge of NMSA by deep percolation of rainfall. The value used by DWR in their 1979 Report (1) has been challenged by The Morro Group as being too low (4). Thus, LFM's current analysis of pumpages, returns, and other elements involving the hydrologic balance was reduced to a parametric estimation of the safe yield of NMSA, in which two significant hydrologic elements, that of recharge by deep percolation of rainfall and subsurface outflow, were altered from "normal" values while holding other elements constant. This was done to explore the effect on hydrologic balance and to compare it with the average change in storage determined from water levels for average periods of time (Fall, 1975, 1985, and 1992). It was found that a fairly good correlation could be found for both periods, 1975-85 and 1985-92.

Under the analytical methods used by LFM, it appeared that the deep percolation of rainfall should probably be considered as about double the value used by DWR. However, the analysis did not suggest that the DWR subsurface outflow figure should be changed materially.

4. Based upon the parametric analysis of data analyzed, it appears that the safe (dependable) yield of NMSA *for pumpage* is in the order of 8,000 AFY and that the overpumpage currently is in the order of 1,200 AFY.

5. When returns are taken into account, it is found that the total current NMSA net pumpage is slightly above 5,500 AFY (7,292 AFY gross - 1,749 AFY returns).

6. The total 1992 safe yield of NMSA under current conditions, **for consumptive use**, according to data analyzed, is calculated as 4,480 AFY (numbers not yet rounded).

7. The safe yield(s) of NMSA cited above are premised upon a continuation of substantial subsurface outflow to adjoining sub-areas within the Arroyo Grande Groundwater Basin, especially into the Santa Maria Valley Sub-Area. However, this condition reflects the nature of the topography, history of pumping, and other hydrologic factors of NMSA and its adjoining sub-areas. There is no physical or legal requirement that such outflow continue at current levels, although it is essential that the subsurface outflow to the Pacific Ocean continue at significant quantities in order to repel seawater intrusion. When the total subsurface outflow leaving NMSA is reduced (arbitrarily) to 50 percent of its current estimated levels, it increases the safe yield of NMSA *for consumptive use* by some 1,525 AFY to a value of 6,005 AFY (number not yet rounded). NCSD would continue to have a pro rata share of this yield. The subsurface outflow will not actually decrease until the groundwater level gradients have diminished sufficiently to cause this, and this will not occur until the NMSA groundwater has been drawn down significantly.

8. NCSD has been recharging the NMSA with treated wastewater treatment plant effluent in generally increasing amounts since 1987. It is estimated that the net recharge during the 5-year period, 1988-92 (after deducting evaporation from treatment and percolation ponds) have amounted to 760 AF. NCSD should receive credit for this recharge in matters pertaining to water rights.

RECOMMENDATIONS

1. NCSD should work towards establishing its water rights for pumpage. Inasmuch as it appears that a modest overdraft exists for NMSA, this would suggest that NCSD pumpage should not necessarily be curtailed but rather should be allowed to increase in response to growing demands.

2. NCSD should encourage SLOCED to expand and maintain its program of well level measurements on NMSA and vicinity (as well as in other areas of San Luis Obispo County) and should continue to cooperate with SLOCED in its regular data gathering program.

3. NCSD should continue to monitor its wastewater treatment plant disposal operation (as required by RWQCB) and to analyze the resulting data from the standpoint of both water quality and quantity.

## REFERENCES


(1) State of California, Department of Water Resources, Southern District "Ground Water in the Arroyo Grande Area," June 1979.

(2) James M. Montgomery, Consulting Engineers, Inc. "Ground Water Availability for the Proposed Black Lake Golf Course Development Project," a report for Plaza Builders, Incorporated, June 1982.

(3) Lawrance, Fisk & McFarland, Inc., "Final Report Water, Wastewater and Drainage Studies, Nipomo Mesa Planning Study," a Report to RRM Design Group for the Nipomo Mesa Technical Study Sponsors, August 24, 1987.

(4) The Morro Group, "Environmental Impact Report, South San Luis Obispo County General Plan Update," ____ 1991.


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