3.1.3. Rainfall

There are six active rainfall gauges available to estimate the NMMA rainfall (Figure 3-4). Three stations are part of the ALERT Storm Watch System, Nipomo East (728), Nipomo South (730), and Oceano (795). One station is a California Irrigation Management Information System (CIMIS station), CIMIS (202). The other two stations are active volunteer gauges and include Mehlschau (38), and Nipomo CDF (151.1). The data are collected by the County of San Luis Obispo Department of Public Works (SLO DPW) and CIMIS. The TG obtains these data by filing a data request with County Public Works at the beginning of the calendar year for the rainfall data from the preceding year. SLO DPW staff collects volunteer gauge data once each year in the month of July for the previous year, July through June. Rainfall data are often compiled on a water year basis. A water year typically begins October 1st and ends September 30st of the following year, and the year referenced is that of September (i.e., WY2003 is defined as October 1, 2002, through September 30, 2003). For the volunteer gauges, data collected from July 2011 to December 2011 is unavailable until July 2012, when County staff collects and compiles the rainfall data.

The WY2011 rainfall totals are approximately 180 percent of the long-term average (Table 3-1). The next water year ending September 30th, 2012, will be likely less than the long-term average. Reference evapotranspiration for calendar year 2011 is 43.6 inches, as compared to 41.7 inches in calendar year 2010.

Table 3-1. Rainfall Gauges and 2011 Rainfall Totals

Rainfall Station	Period of Record	Period of Record Mean	Water Year 2011[1]	Calendar Year 2011	Percent of Normal[2]
Nipomo East (728)	2005-2011	18.01	30.27	16.61	191%
Nipomo South (730)	2005-2011	16.70	27.25	13.98	172%
Oceano (795)	2005-2011	14.63	23.57	12.87	149%
CIMIS Nipomo (202)	2006-2011	14.36	27.18	16.54	171%
Nipomo CDF (151.1)	1958-2011	15.87	34.05*	NA	215%
Mehlschau (38)	1920-2011	16.83	28.91*	NA	182%

Notes:
NA - Data not available from July 2011 to December 2011 until July 2012.
1. Water Year is defined as Oct. 1 of previous year through Sept. 30 of the current year.
2. Percent of Normal, calculated using the period of record annual averages for #151.1.
* Voluntary gauge data collection occurs in July of each year, and rainfall is assumed to be zero for the remainder of the WY (July, August, and September).

3.1.4. Rainfall Variability

Quantifying the temporal and spatial variability is critical where rainfall is a large portion of the water supply. Spatial variability in the volume of rainfall across the NMMA is apparent when comparing the WY2011 rainfall totals from these gauges. The WY2011 total rainfall ranges from 23.6 inches (Nipomo South #795) to 34.0 inches (Nipomo CDF #151).

Climatic trends and interannual variability also impact the water supply to the NMMA. The cumulative departure from the mean was prepared for two rain gauge stations Mehlschau (38) and

Nipomo CDF (151.1) over the period from water year 1975 to water year 2011 (Figure 3-5). Periods of wetter than average and drier than average conditions are coincident at both gauges. The most pronounced dry period occurred from 1983 to 1994, followed by a wetter than average period from 1994 to 1998. A more recent dry period occurred from 2001 to 2009, with 2005 and 2006 being wetter than average. Since 2010, wet conditions have occurred.

3.1.5. Streamflow

Currently, there are some records of streamflow within the NMMA. On Los Berros Creek, the Los Berros 757 streamflow sensor is located 0.8 miles downstream from Adobe Creek and 3.7 miles north of Nipomo on Los Berros Road and the Valley Road (Sensor 731) is located on at the Valley Road bridge over Los Berros Creek (Figure 3-6). The data at the Los Berros gauge are compiled by San Luis County Department of Public Works. Nipomo Creek streamflow is not currently gauged.

3.1.6. Surface Water Usage

There are no known diversions of surface water within the NMMA.

3.1.7. Surface Water Quality

Surface water quality samples were taken in Nipomo Creek in 2001 and 2002 and in Los Berros Creek in 2002 and 2003 for the Central Coast Ambient Monitoring Program (www.ccamp.org). Nipomo Creek was listed as an impaired water body because of fecal coliform counts in exceedance of the basin plan standard. There are no known surface water quality samples taken since the CCAMP sampling.

3.1.8. Land Use

Land use data historically has been collected for the NMMA by the DWR at approximately ten year intervals since 1959. DWR periodically performs land use surveys of the Southern Central Coast area (which includes the NMMA). The TG will decide when the next land use survey should be completed. Ideally, DWR will update the land use for the South Central Coast area (which includes the NMMA) in the future for the next land use survey. The status of the DWR land use program for the Southern District can be accessed at (http://www.dpla.water.ca.gov/sd/land_use/landuse_surveys.html).

The most recent DWR Land Use survey that covers the NMMA was in 1996. The 2007 NMMA land use was classified by applying the DWR methodology to a June 2007 one-foot resolution aerial photograph. Land use was classified into four main categories based on the methodology used by DWR in 1996; agriculture, urban, golf course and native vegetation (undeveloped lands).

Agricultural lands for 2009 were further subdivided using the San Luis Obispo County Agriculture Commissioner survey of the 2009 crop types and acreage for San Luis Obispo County. The major crops grown on in the NMMA are strawberries, vegetable rotational, avocados, and nursery plants.

Urban lands were classified following the DWR methodology with additional sub categories based on San Luis Obispo County land use categories from land use zoning maps. The categories for urban include (1) Commercial-Industrial; (2) Commercial-office, (3) Residential Multi-family; (4) Residential-Single Family; (5) Residential-Suburban; (6) Residential-Rural; (7) Recreational grass; (8) Vacant. Golf courses were classified separately from Agricultural or Urban Lands.

Native vegetation lands were classified following the 1996 DWR methodology. In the DWR methodology, all undeveloped land was classified as native vegetation and includes groves of non-native eucalyptus and fields of non-native grasses. The lands classified as native vegetation were further broken down into two categories: grasses; and trees and shrubs; to better estimate deep percolation of rainfall required for the hydrologic inventory (see Section 5 Hydrologic Inventory).

The land use acreage for Urban is 10,246 acres; for Agriculture is 2,587 acres; and for Native is 8,314 acres. Sub categorical land use acreage is also defined and will subsequently be utilized to compute the groundwater productions and consumptive use of water for each subcategory (Table 3-2).

Table 3-2. Land Use Summary

Land Use Category	Year of Data	Acreage
Urban		
Commercial – Industrial	2007	472
Commercial – Office	2007	118
Golf Course	2007	549
Residential Multi-family	2007	24
Residential Single Family	2007	821
Residential Suburban	2007	3,597
Residential Rural	2007	4,629
Recreational grass	2007	36
Urban Total	**2007**	**10,246**
Agriculture		
Deciduous	2009	2
Pasture	2009	2
Vegetable rotational	2009	225
Avocado and Lemons	2009	277
Strawberries	2009	1,393
Nursery	2009	332
Non-irrigated farmland	2007	356
Agriculture Total	**2007**	**2,587**
Native Vegetation		
Fallow Ag Land	2007	234
Native Trees and Shrubs	2007	2,657
Native Grasses	2007	4,579
Urban Vacant	2007	765
Water Surface	2007	9
Unclassified	2007	70
Native Total	**2007**	**8,314**
Total Land Use		**21,147**

3.1.9. Groundwater Production (Reported and Estimated)

The groundwater production data presented in this section of the Annual Report were collected for calendar year 2011. Where groundwater production records were unavailable, the groundwater production was estimated for calendar year 2011 (Figure 3-7).

Reported Groundwater Production

Individual landowners, public water purveyors, and industry all rely on groundwater pumping from the aquifers underlying the NMMA. Data were requested by the TG from the public water purveyors and individual pumpers and incorporated in this calendar year 2011 Annual Report. Stipulating Parties to the Judgment are required to provide monitoring and other production data at no charge, to the extent that such data have been generated and are readily available.

Stipulating parties provided production records that report a total of 6,223 acre feet (AF) of groundwater produced in calendar year 2011 (Table 3-3) , an increase of 123 AF from last year. NCSD, Woodlands, and RWC increased production in 2011 compared to 2010. Woodlands increase in production is consistent with the planned build-out of the development. GSWC production is lower this year as compared to last year.

Table 3-3. Calendar Year 2011 Reported Groundwater Production

Stipulating Parties	Production (AF/yr)
NCSD	2,488
GSWC	1,043
Woodlands	864
ConocoPhillips	1,100
RWC	728
Subtotal	**6,223**

Estimated Production

The estimated production for agricultural crops in the NMMA is 2,465 AF computed on a daily time-step by multiplying the crop area and the crop specific water demand met by either soil moisture, rainfall, or groundwater production, thus developing the unit production for calendar year 2011 (Table 3-4). A detailed explanation of the methodology used for this estimate is provided in Appendix E, Table 1.

Table 3-4. 2011 Estimated Groundwater Production for Agricultural

Crop Type	2011 Area (Acres)	2011 Unit Production (AF/acre)	2011 Production (AF/yr)
Deciduous	2	2.0	4
Pasture	2	2.5	5
Vegetable Rotational	225	1.9	437
Avocado and Lemon	277	1.2	320
Strawberries	1,393	1.0	1341
Nursery	332	1.1	358
Un-irrigated Ag Land	356	0.0	0
Total	**2,587**		**2,465**

Estimated groundwater production for urban use was estimated for rural landowners not served by a purveyor. The total estimated production for the rural landowners is 1,850 AF for calendar year 2011 (Table 3-5).

Table 3-5. Estimated Groundwater Production for Rural Landowners

Land Use Type	Water Use Area (acres)	Unit Production (AF/acre)[1]	Production (AF/yr)
Golf Course	549	1.4	762
451RS Zoned Parcels	172	2.6	452
616 RR Zoned Parcels	243	2.6	637
Total	**414.75**		**1,850**
Note:			
1. Unit production values from NCSD 2007, Water and Sewer Master Plan Update			

Combining the estimates of groundwater production for Stipulating Parties (Table 3-3), for Agriculture (Table 3-4) and Rural Landowners (Table 3-5) results in an estimated total groundwater production of 10,538 AF for calendar year 2011 (Table 3-6).

Table 3-6. 2011 Measured and Estimated Groundwater Production (AF/yr)

Measured	
NCSD	2,488
GSWC	1,043
Woodlands	864
ConocoPhillips	1,100
RWC	728
Subtotal	**6,223**
Estimated	
Rural Landowners	1,850
Agriculture	2,465
Total NMMA Production	**10,538**

3.1.10. Wastewater Discharge and Reuse

Five wastewater treatment facilities (WWTF) discharge treated effluent within the NMMA: the Southland Wastewater Works (Southland WWTF), the Blacklake Reclamation Facility (Blacklake WWTF), Rural Water Company's Cypress Ridge Wastewater Facility (Cypress Ridge WWTF), the Woodlands Mutual Water Company Wastewater Reclamation Facility (Woodlands WWTF) (Figure 3-8). The Golden State Water Company La Serena Groundwater Manganese Removal Treatment Plant (La Serena) discharges filter backwash to percolation ponds. The total waste water discharge in the NMMA was 780 AF for calendar year 2011 (Table 3-7).

Table 3-7. 2011 Wastewater Volumes

WWTF	Influent (AF/yr)	Estimated Effluent (AF/yr)	Re-use
Southland	711	629 (1)	Infiltration
Blacklake	71	61 (1)	Irrigation
Cypress Ridge	Not Reported	44	Irrigation
Woodlands	Not Reported	40	Irrigation
La Serena	Not Reported	6 (2)	Infiltration
Total		**780**	

Notes:

1. Effluent was estimated as the sum of Influent - Evaporation from Aeration Ponds - 10% of Influent to account for biosolid removal. For the Nipomo Mesa calendar year 2011, the annual evapotranspiration measured at CIMIS 202 gage is 43.6 inches and the rainfall measured at CIMIS 202 gage is 16.54 inches (CIMIS, 2011). This results in a net evaporation from a pond of 27.06 inches per year.
2. GSWC's La Serena Groundwater Manganese Removal Treatment Plant treats water from GSWC's La Serena and Eucalyptus wells. Filter backwash water is discharged to percolation ponds, where water infiltrates into the basin.

3.2. ***Database Management***

The database of monitoring data is an entirely digital database and is maintained in Microsoft Excel as a confidential document. The database is broken into five datasets: Groundwater elevation, groundwater production, wastewater treatment, stream flow, groundwater quality, climate, and land use.

NCSD's technical representative is currently designated as the database steward and is responsible for maintaining and updating the digital files and for distributing any updated files to other members of the TG. A "change log" is maintained for each database. The date and nature of the change, along with any special features, considerations or implications for linked or related data are recorded in the change log. The Stipulation and Judgment require that absent a Court order or written consent, the confidentiality of well data from individual owners and operators is to be preserved.

3.3. ***Data and Estimation Uncertainties***

Uncertainties exist in data, and therefore uncertainties exist in derivatives of data including interpretations and estimations made from direct measurements. Uncertainties arise from errors in measurements, missing measurements, and inaccurate methodologies and generalizing assumptions. For example, rainfall is measured at a few locations across the NMMA. However, it is well known that the spatial and temporal variability in rainfall deposition in a storm is much greater than that which the density of rainfall gauges can represent. Ground surface elevation across the NMMA is known to be in error at places and may be reported incorrectly by amounts as large as 20 feet. This affects the accuracy of groundwater elevations and contours. There exists missing data from both groundwater elevations and rainfall records. Estimations are made to fill in these data gaps with the understanding that the accuracy of these estimates is reduced. Derivatives from these data therefore contain inaccuracies. Additionally, precision issues arise when interpretations are made from data, in that individuals make decisions during the process of interpreting data that are subjective and therefore not documentable. For example, aerial image classification is a subjective process as is the preparation of groundwater elevation contours. Estimations are made for parameters that are not measurable or very difficult to measure. The methodologies used to make estimates represent a simplified numerical representation of the environment and are based on assumptions defining these simplifications. Quantifying the uncertainty in data or data derivatives is a rigorous and ongoing process.

The measured groundwater production values are reliable and are considered precise to the tens place for NCSD, GSWC, and Woodlands, RWC and the hundreds place for ConocoPhillips. The estimated production values are less reliable and precise for the rural residence groundwater production. The unit production factors used to estimate the rural residence groundwater production were developed for the NCSD Water and Sewer Master Plan (see Section 3.1.8 Land Use). For the estimated agricultural production, there is no measured data available in the NMMA to verify the precision or reliability of the agricultural production.

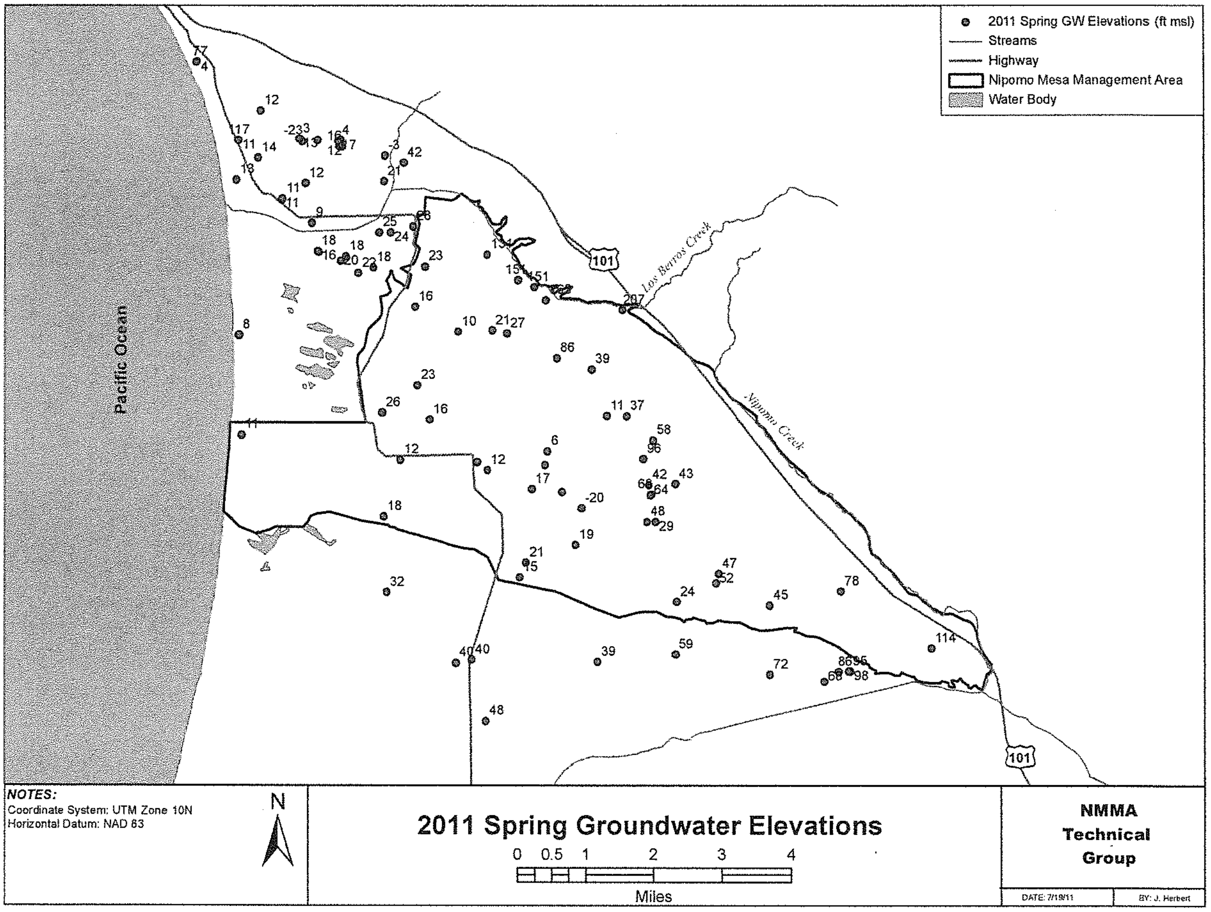

Figure 3-1. 2011 Spring Groundwater Elevations

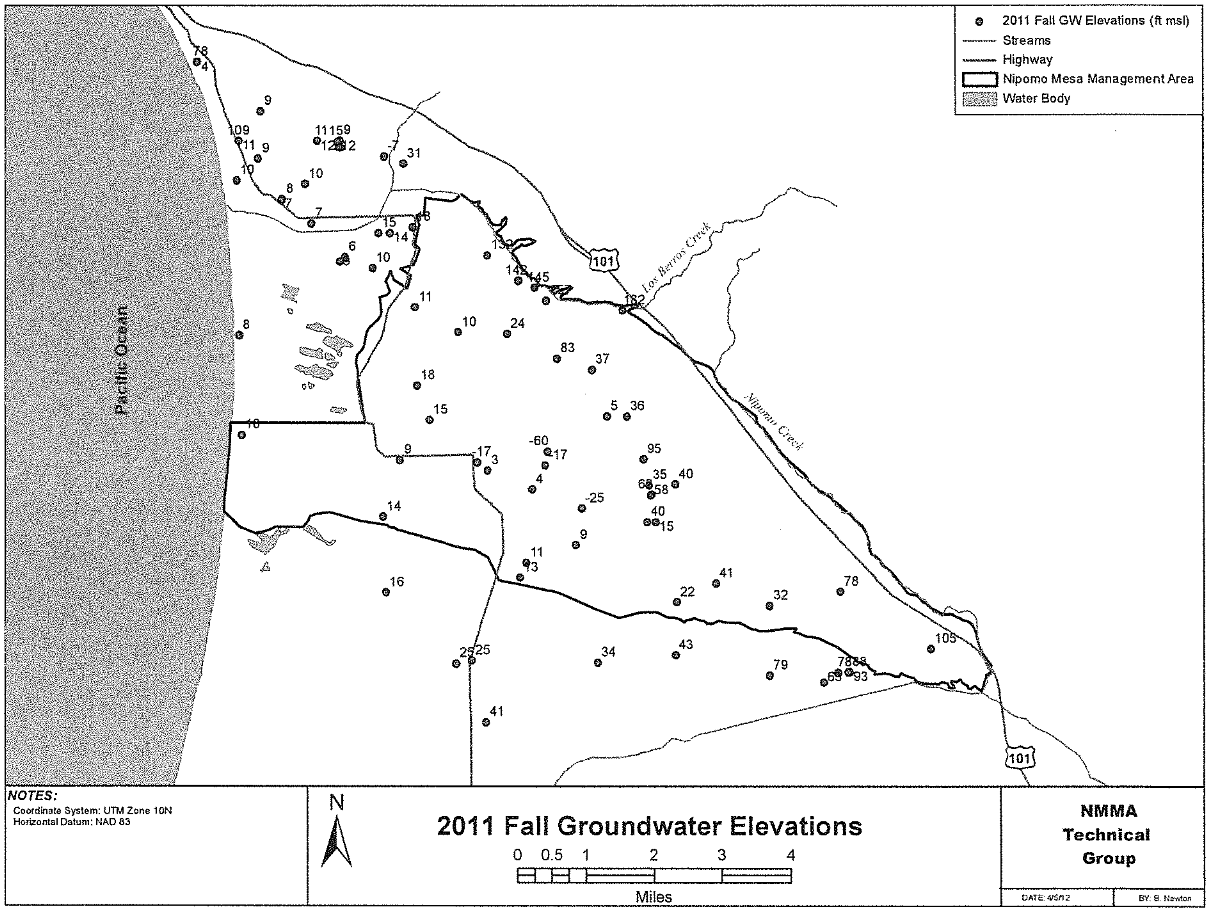

Figure 3-2. 2011 Fall Groundwater Elevations

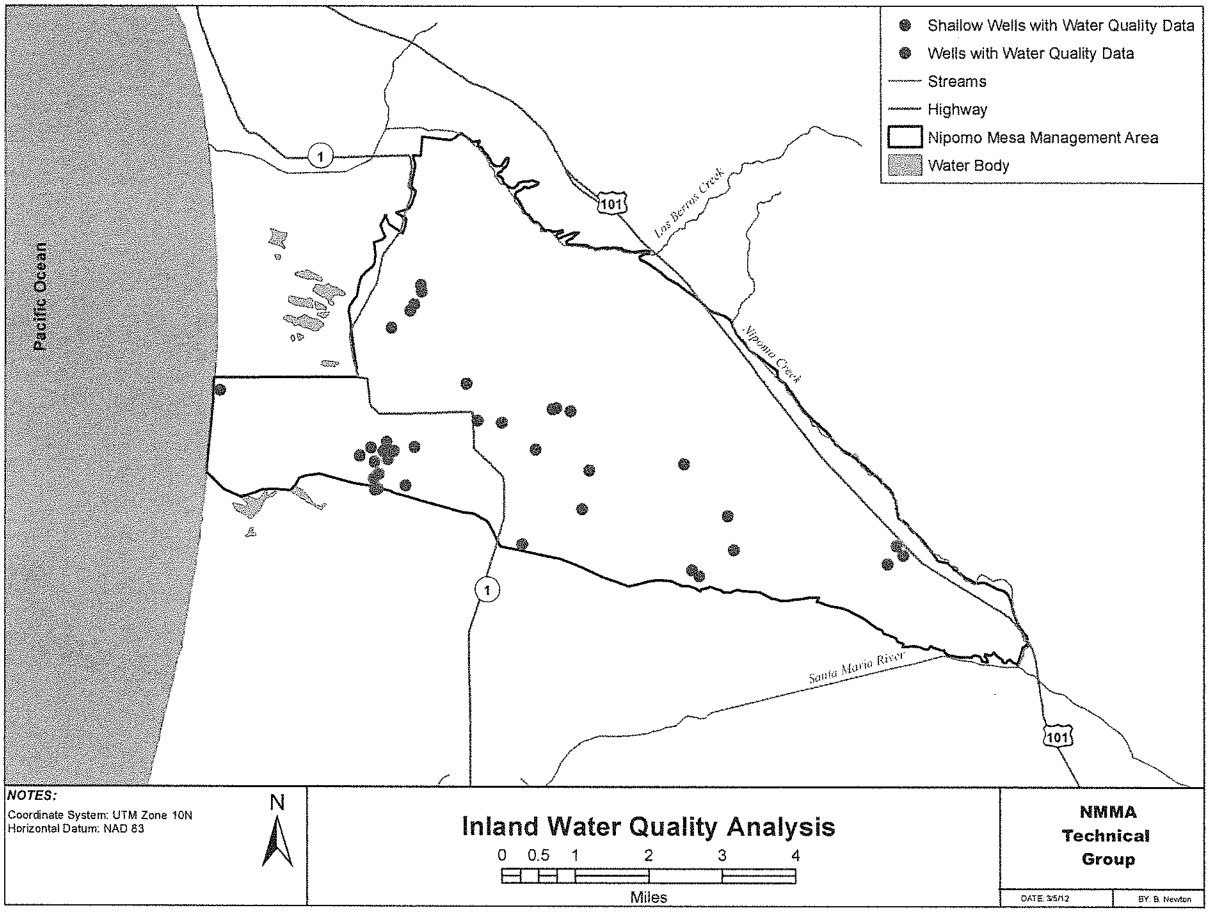

Figure 3-3. Locations of Water Quality Data

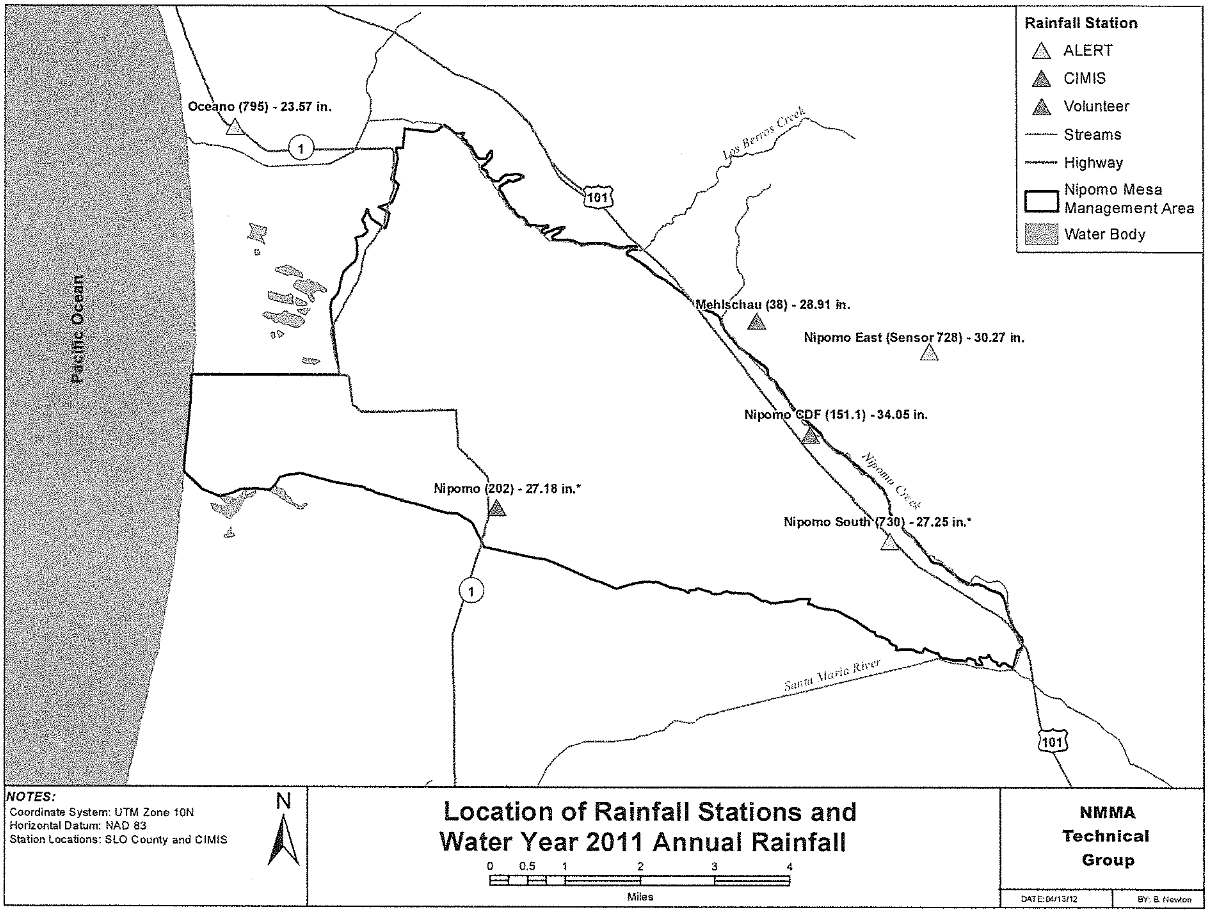

Figure 3-4. Rainfall Station Location and Water Year 2011 Annual Rainfall

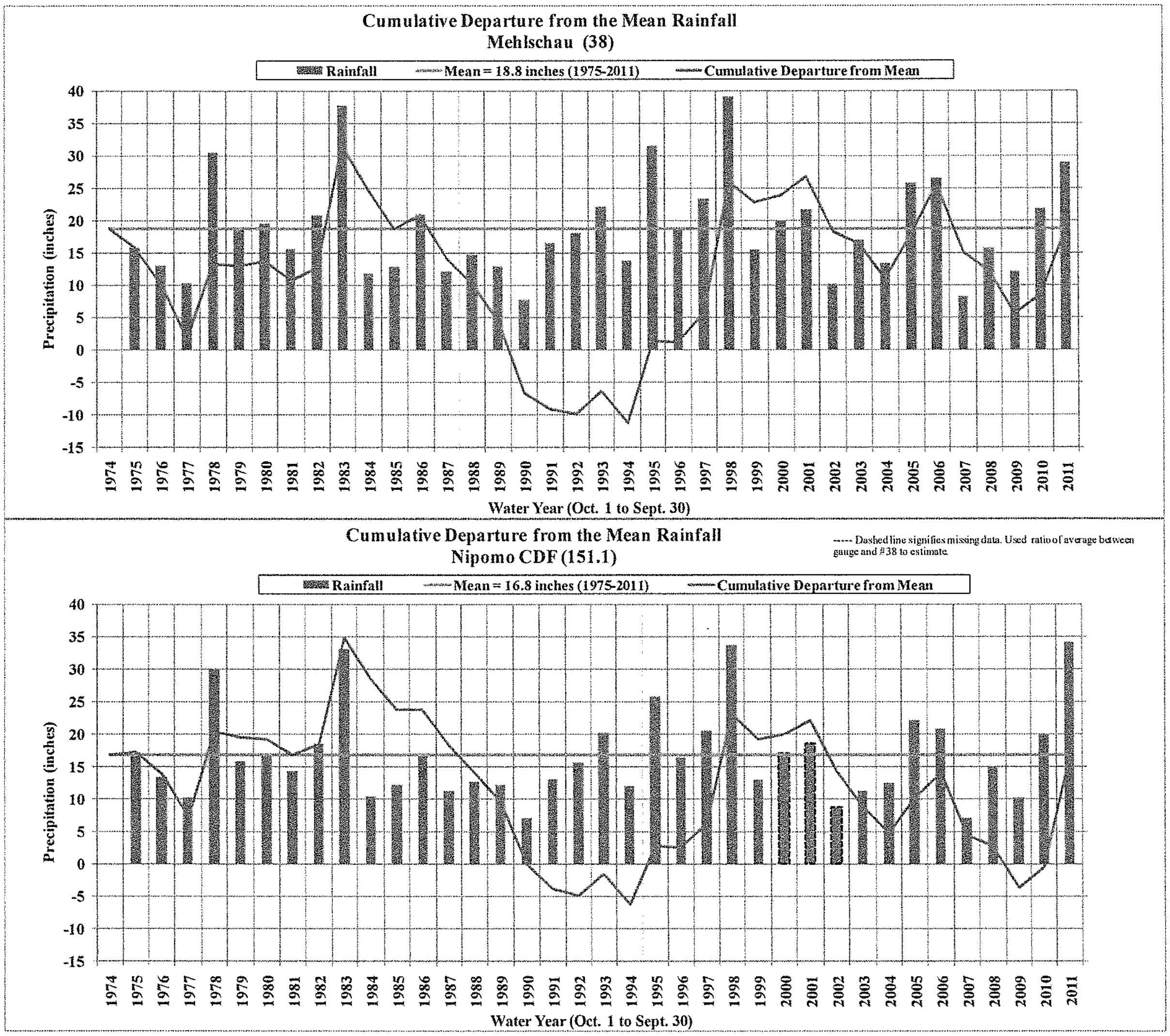

Figure 3-5. Cumulative Departure from the Mean for the following rain gauges: Mehlschau (38) and Nipomo CDF (151.1)

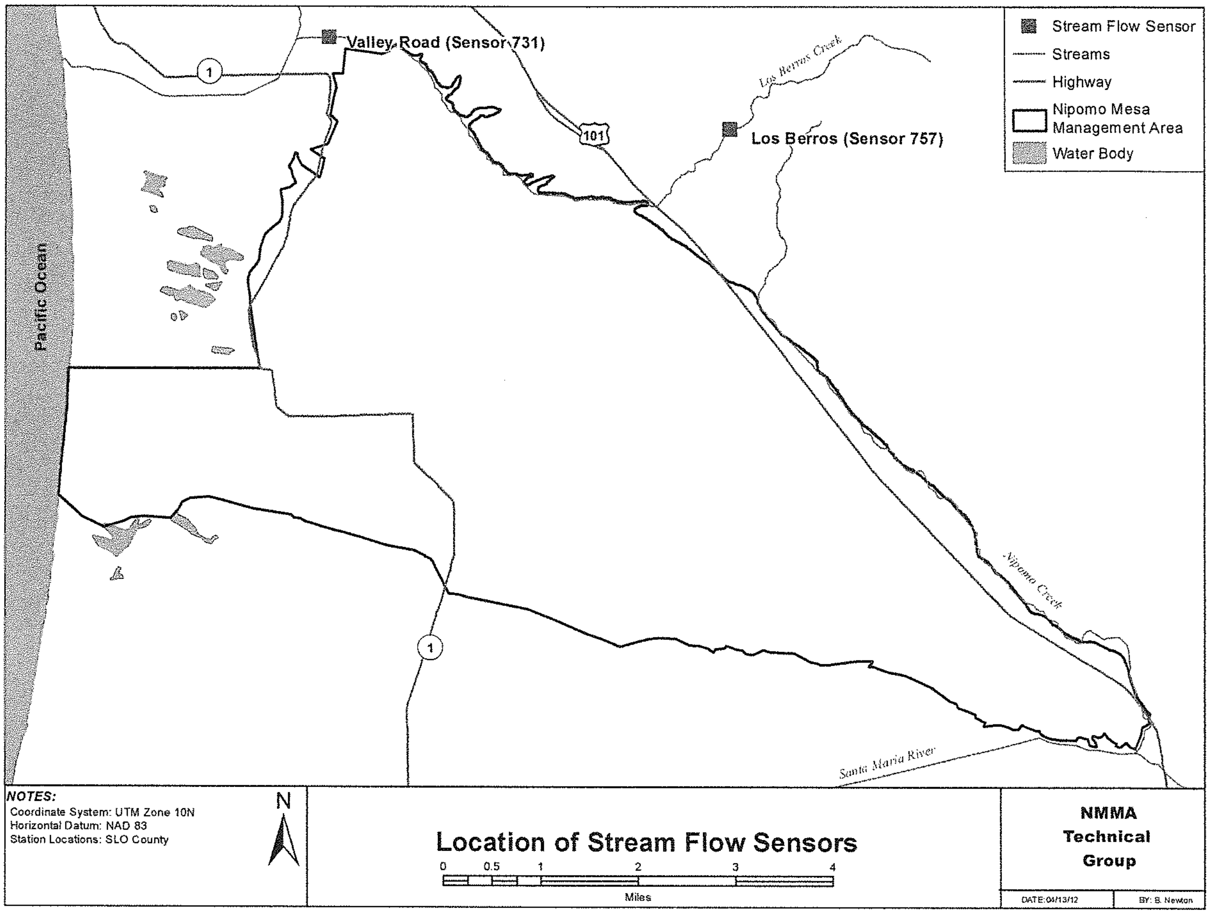

Figure 3-6. Location of Stream Flow Sensors

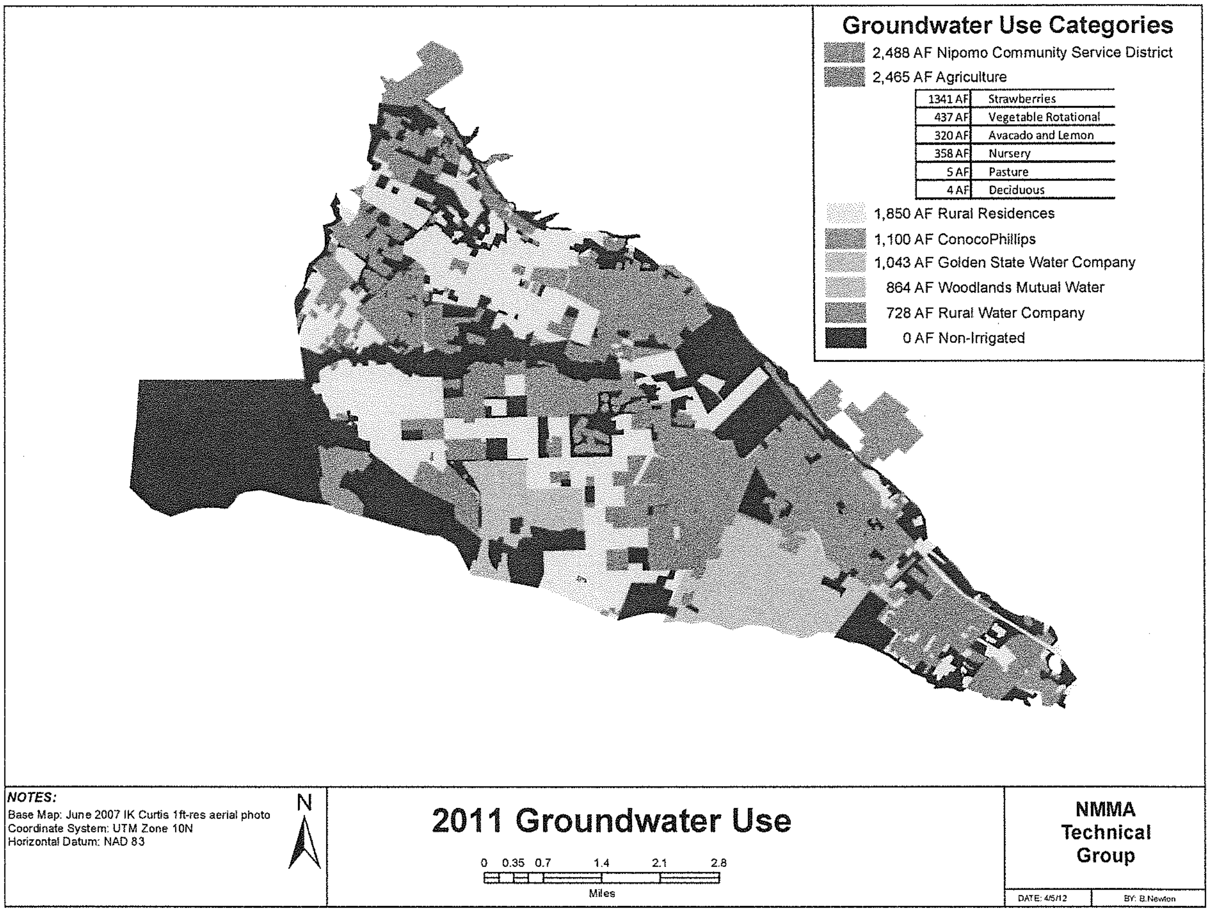

Figure 3-7. 2011 Groundwater Use

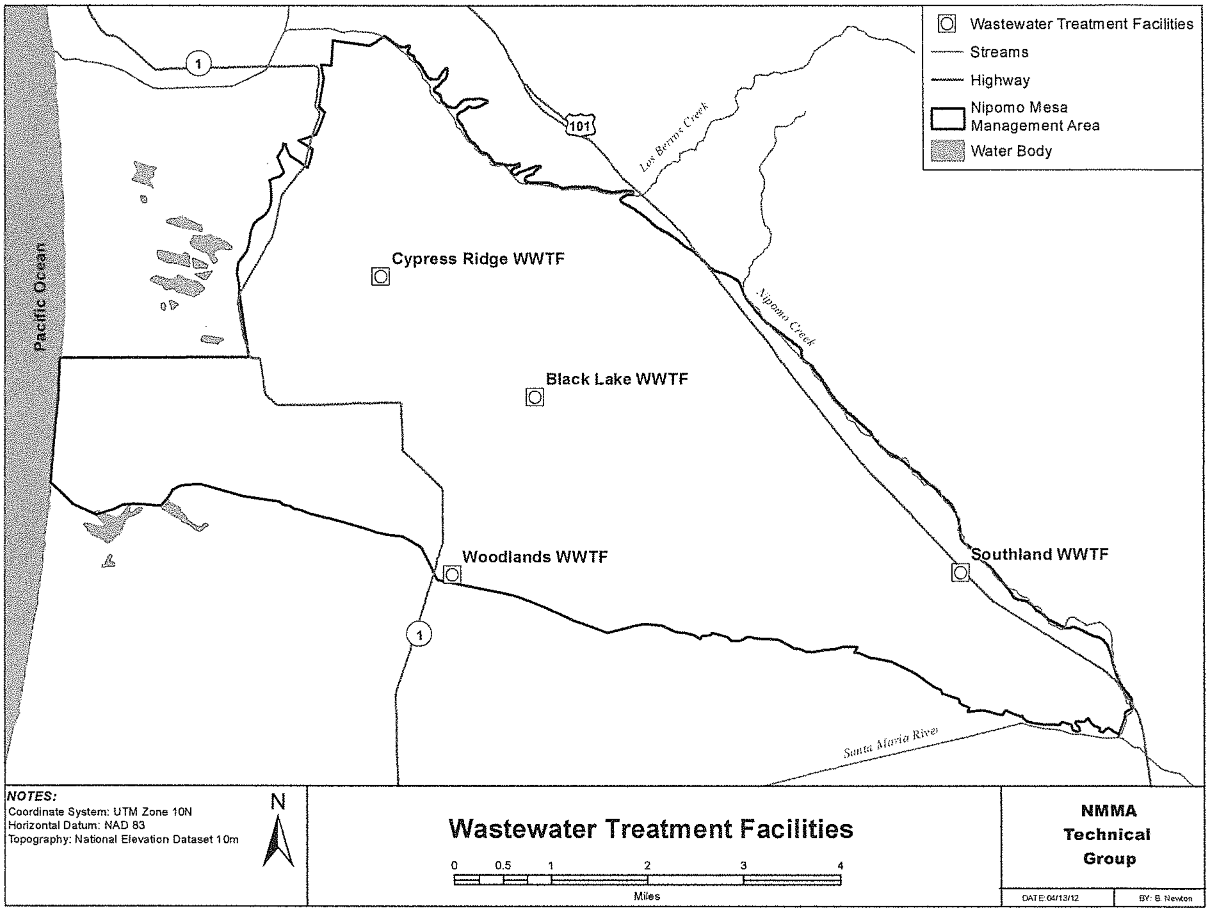

Figure 3-8. Wastewater Treatment Facilities

4. Water Supply & Demand

Presented in this section are discussions of the various components of current and projected estimates of water supplies and demands for the NMMA.

4.1. *Water Supply*

The water supplies supporting the activities within the NMMA are met primarily from groundwater production with a minor amount of recycled water. No surface water diversions exist, nor is there currently any imported water. Supplemental Water, as defined by the Stipulation, is being developed and delivery is expected within the next few years. A brief description of the groundwater production, recycled water, Supplemental Water, and surface water diversion is presented in the following sections.

4.1.1. Groundwater Production

Currently, groundwater pumping is not differentiated between various strata, shallow or deep aquifers. The specifics of shallow and deep aquifer production are better known by the TG for purveyor wells which produce primarily from the deep aquifers, but this information is not available for many more private wells in the NMMA.

Shallow Aquifers

Domestic production by rural landowners was estimated to be about 1,089 AF/yr (see Table 3-5. Estimated Groundwater Production for Rural Landowners). The majority of this production may be from the Shallow Aquifers. A portion of the estimated 2,465 AF agricultural pumping may also be from the Shallow Aquifers.

Deep Aquifers

All production from wells used for public drinking water and industrial water is likely pumped from the Deep Aquifers (primarily the Paso Robles Formation). This pumping is estimated to be about 8,073 AF (see Table 3-4 and Table 3-5). In addition, a portion of the estimated 2,465 AF/yr of agricultural pumping may also be produced from the Deep Aquifers.

4.1.2. Recycled Water

Wastewater effluent from the golf course developments at Blacklake Village, Cypress Ridge, and Woodlands is recycled and utilized for golf course irrigation. The amount of recycled water used in calendar year 2011 for irrigation at Blacklake Village, Cypress Ridge and Woodlands are 61 AF, 44 AF, and 40 AF, respectively (see Section 3.1.10 Wastewater Discharge and Reuse).

4.1.3. Supplemental Water

There was no Supplemental Water delivered to the NMMA in calendar year 2011.

4.1.4. Surface Water Diversions

There are no known surface water diversions within the NMMA.

4.2. *Water Demand*

The water demands in the NMMA include urban (residential, commercial, industrial), golf course, and agricultural demands. The TG used a variety of methods to estimate the water demands of the respective categories (see Section 3.1.9 Groundwater Production (Reported and Estimated)).

4.2.1. Historical Demand

The historical demand estimated for urban (including golf course and industrial) and agricultural land uses has been steadily increasing since 1975 with urban accounting for the largest increase in total volume and percentage (Figure 4-1).

4.2.2. Current Demand

The estimated demand is 10,538 AF for Calendar Year 2011, based on annual groundwater production records provided by the water purveyors on the Nipomo Mesa, an estimated groundwater production by land use area (see Section 3.1.8 Land Use), and recycled water use (see 3.1.10 Wastewater Discharge and Reuse). This amount of demand represents a decrease of 412 AF from the previous year, as reported in the 3rd Annual Report Calendar Year 2010. The TG has not differentiated the causes of this reduction; possible causes include reduced potential evapotranspiration and increased rainfall, conservation measures, and economic forces.

4.2.3. Potential Future Production (Demand)

The projected future demand for NCSD is an increase from 2,293 AF/yr in calendar year 2010 to 3,400 AF/yr in 2030 (NCSD, UWMP 2010 – Table 21 and 23). The ConocoPhillips refinery expects future production to be similar to recent years' production amounts of approximately 1,200 AF/yr. The projected water demand for Woodlands at build-out according to the Woodlands Specific Plan EIR is 1,600 AF/yr (SLO, 1998). The projected water demand for the GSWC at full build-out of current service area is estimated to potentially increase to approximately 1,940 AF/yr in 2030 (GSWC, 2008). Currently, no estimate of potential future production for agriculture has been developed. Future production from the Groundwater Basin is restricted by San Luis Obispo County Ordinance §3090 (adopted May 2006) which provides that Land Divisions authorized by the current South County Area Plan (Inland) pay a supplemental water charge Not-to-Exceed $13,200 for each dwelling unit equivalent and further provides that future General Plan Amendments will not be approved unless supplemental water to offset the proposed development's estimated increase in non-agricultural demand has been specifically allocated for exclusive use of the development resulting from the General Plan Amendment and is available for delivery to the Nipomo Mesa Water Conservation Area. In the future, it is expected that a portion of the demand will be met by the Supplemental Water and delivery of supplemental water, and possibly better utilization of recycled water. It should be noted that the County of San Luis Obispo has yet to formally adopt a supplemental water in-lieu fee; and absent the adoption, there is some uncertainty about the supplemental water in-lieu fee to be applied in accordance with County Ordinance §3090.

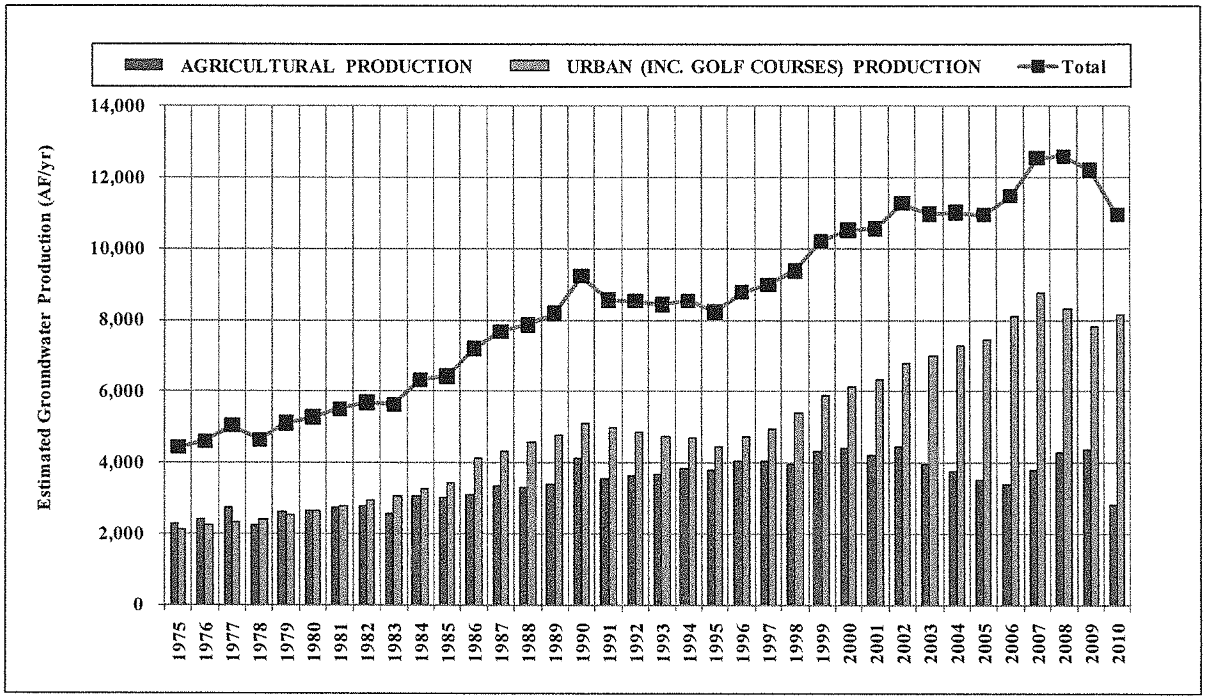

Figure 4-1. Historical NMMA Groundwater Production

5. Hydrologic Inventory

The hydrologic inventory accounts for the volumes of water that flow in to and out of the aquifers in the NMMA resulting in the change in storage. A conceptual schematic depicts the inflows and outflows to the aquifers underlying the NMMA (Figure 5-1). The hydrologic inventory can be formalized in the following equation:

$$\text{Change in Storage } (\Delta S) = \text{Inflow} - \text{Outflow}.$$

In the following sections the components of the 2011 hydrologic inventory are presented and discussed. The principal sources of inflow are rainfall, streamflow, wastewater, groundwater (i.e. subsurface flow across the boundaries of the NMMA) inflow, and return flow. The principal outflows are groundwater production and groundwater outflow. Supplemental Water is also discussed as a potential future supplemental source of inflow.

5.1. *Rainfall and Percolation Past Root Zone*

Rainfall measurements made during calendar year 2011 range from 26 to 34 inches for water year 2011, and are approximately 180 percent of the average long-term annual rainfall (see Section 3.1.3 Rainfall). Rainfall on the NMMA infiltrates the soil surface and is either stored in the soil profile until it is evaporated or transpired by overlying vegetation, or percolates downward into shallow or deep aquifers. Rainfall on hardscape surfaces flows to local depressions where infiltration occurs. Locally rainfall may generate runoff from the NMMA to places adjacent to the NMMA boundary; however, the amount of runoff out of the NMMA is negligible. The TG has estimated the portion of rainfall that percolates past the root zone is 12,296 AF in water year 2011.

5.2. ***Subsurface Flow***

The groundwater subsurface flow is the volume of water that flows into and out of the NMMA groundwater system. Typical methods used to estimate subsurface flow is Darcy's equation (using hydraulic conductivity, groundwater gradient, and aquifer thickness) or flow equations that are part of a regional groundwater model. In the NMMA, the three areas with the most potential for subsurface flow are at the northwestern boundary with the Northern Cities Management Area, the southern boundary with the Santa Maria Valley Management Area, and the seaward edge of the basin. Contours of groundwater elevations in this report (Section 6.1.4 Groundwater Gradients) suggest that there is net inflow from the Santa Maria Valley Management Area, net outflow at the coast (required to prevent seawater intrusion), and subsurface flow into or out of the Northern Cities Management Area. The amount of inflow across the eastern boundary is not well understood.

The nature and extent of the confining layer(s) beneath the NMMA and the extent that faults in the NMMA may act as barriers to subsurface flow are not well understood. The TG has not yet quantified the subsurface flows; however, the TG is currently evaluating detailed hydrogeologic cross-sections along portions of the NMMA boundary necessary to make estimates of subsurface flow (See Section 9 Recommendations).

5.3. ***Streamflow and Surface Runoff***

Streamflow and surface runoff are the volumes of water that flow into and out of the NMMA through surface water channels or as overland flow. Streamflow includes water within the Los Berros Creek, Nipomo Creek, and Black Lake Creek (Figure 5-2). Surface runoff occurs during major rainfall events and could occur in locations where local conditions near the NMMA boundary are sufficient to promote overland flow out of the area, and where shallow subsurface flow contributes to streamflow that is conveyed out of the NMMA, or to coastal dune lakes where it evaporates. This may occur in the following areas (Figure 5-2):

- Los Berros Creek streamflow into and out of the NMMA,
- Nipomo Creek streamflow into and out of NMMA,
- Black Lake Canyon streamflow out of the NMMA,
- Surface runoff from steep bluffs adjacent to Arroyo Grande Valley, and
- Surface runoff from steep bluffs adjacent to Santa Maria River Valley.

The volume of streamflow which enters and leaves the NMMA is not well understood. The TG continues to analyze where it might be appropriate to install temporary or permanent stream gauging sites to determine the volume of water that percolates beneath streams in the NMMA.

5.4. ***Groundwater Production***

The groundwater production component of the Hydrologic Inventory is calculated using metered production records where available and estimated from land use data where measurements are unavailable. The calendar year 2011 groundwater production is approximately 10,538 AF (See Section 4.2.2 Current Demand).

5.5. *Supplemental Water*

Supplemental Water is the volume of water produced outside the NMMA and delivered to the NMMA. There was no supplemental water delivered to the NMMA in calendar year 2011. Future deliveries of supplemental water will be measured and subsequent Annual Reports will present the volume and disposition of the supplemental water delivered to the NMMA. An evaluation of the basin impacts from the potential future importation of the proposed NSWP water is presented in an appendix to this Annual Report (see Appendix F).

5.6. *Wastewater*

Wastewater discharges include the volumes of wastewater effluent discharged by the five wastewater treatment facilities located within the NMMA, and individual septic tanks where centralized sewer service is not provided. Wastewater discharges are estimated for the calendar year 2011. The WWTFs include the Southland Wastewater Works (Southland WWTF), the Blacklake Reclamation Facility (Blacklake WWTF), Rural Water Company's Cypress Ridge Wastewater Facility (Cypress Ridge WWTF), the Woodlands Mutual Water Company Wastewater Reclamation Facility (Woodlands WWTF), and La Serena (GSWC). The Southland WWTF discharges treated wastewater into infiltration basins (See Section 3.1.10 Wastewater Discharge and Reuse). A portion of the water percolates and returns to the groundwater system and the remaining portion evaporates. The estimated percolation from Southland WWTF is 629 AF. The treated effluent from Blacklake WWTF (61 AF), Cypress Ridge WWTF (44 AF), and Woodlands WWTF (40 AF) is used to irrigate golf course landscaping, reducing the demand for groundwater production. La Serena discharged 6 AF. The total WWTF effluent in the NMMA was 780 AF (Table 3-7). The wastewater discharged in septic systems percolates downward and may recharge the Shallow Aquifers, the Deep Aquifers, or become shallow subsurface flow outside the NMMA. The estimated amount of return flow from indoor use by rural residences is 180 AF.

5.7. *Return Flow of Applied Water and Consumptive Use*

Return flow is defined as the amount of recharge to the aquifers resulting from applied water that percolates past the root zone to recharge the aquifer(s). This functional definition differs somewhat from that used in the Stipulation to apportion the right to use water that was imported to the basin. However, the physical process of recharge by return flow of applied water is the same regardless of where the water originated.

The TG currently assumes that with the exception of NCSD, Woodlands, GSWC, ConocoPhillips, and RWC, all other groundwater produced for outdoor use is attributable to sustaining plant life and replenishing soil profile storage, and that only rainfall generates percolation. Rural residences produce groundwater for indoor use in addition to outdoor use. The estimated amount of return flow from indoor use by rural residences is 180 AF. The estimated amount of return from urban outdoor water use is 44 percent of the water supplied by NCSD, Woodlands, GSWC, and RWC. The total amount of return flow from outdoor water use is thus 44 percent of 5,123 AF (Table 3-3), or about 2,050 AF, because no return flow occurs from ConocoPhillips' groundwater production. The estimated total return flow, which includes 180 AF of recharge from septic systems (See Section 5.6), is 2,230 AF in calendar year 2011.

The estimated consumptive use of water in the NMMA, computed by subtracting the return flow from the groundwater production, is approximately 8,308 AF.

5.8. *Change in Groundwater Storage*

The change in groundwater storage from the hydrologic inventory reflects the difference between inflow and outflow for a period of time. Typically, this change in storage is compared to a change in storage computed from groundwater contours, cross-checking the results of each. Storage changes from groundwater contours are typically calculated by measuring change in groundwater elevation and multiplying that change by a storage factor. The TG's current understanding of confining conditions within the NMMA precludes calculating change in groundwater storage from groundwater contours at this time for the management area.

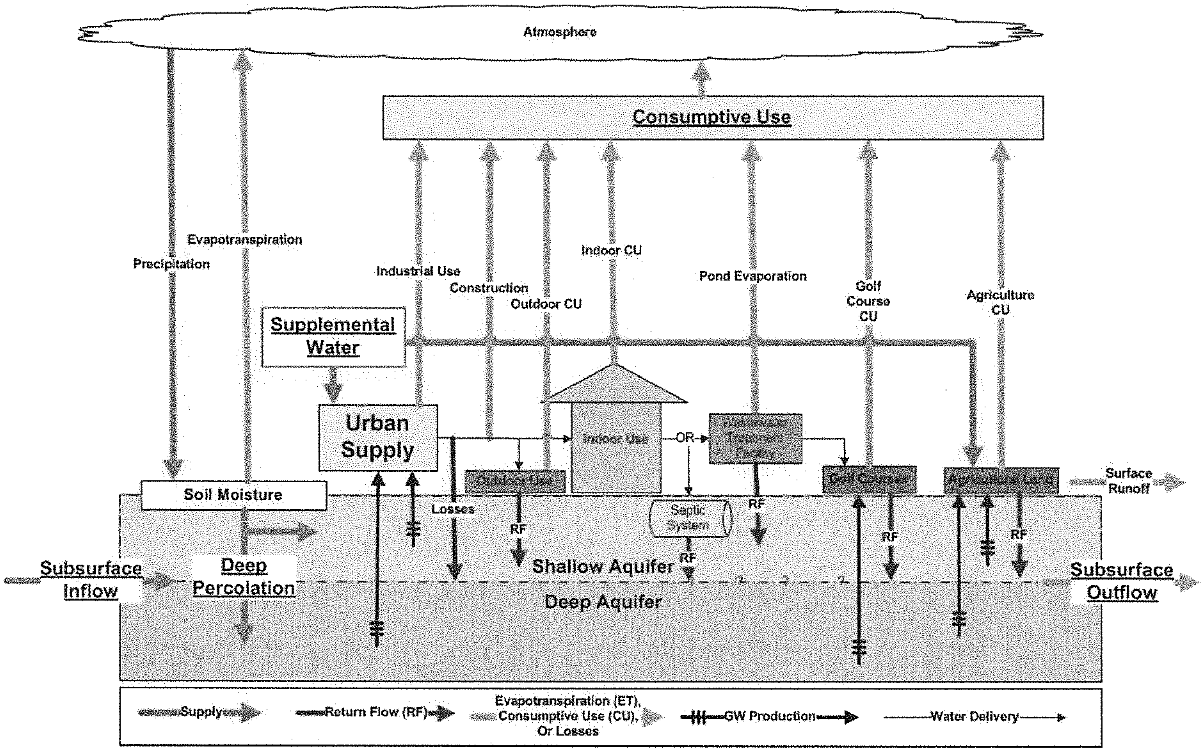

Figure 5-1. Schematic of the Hydrologic Inventory

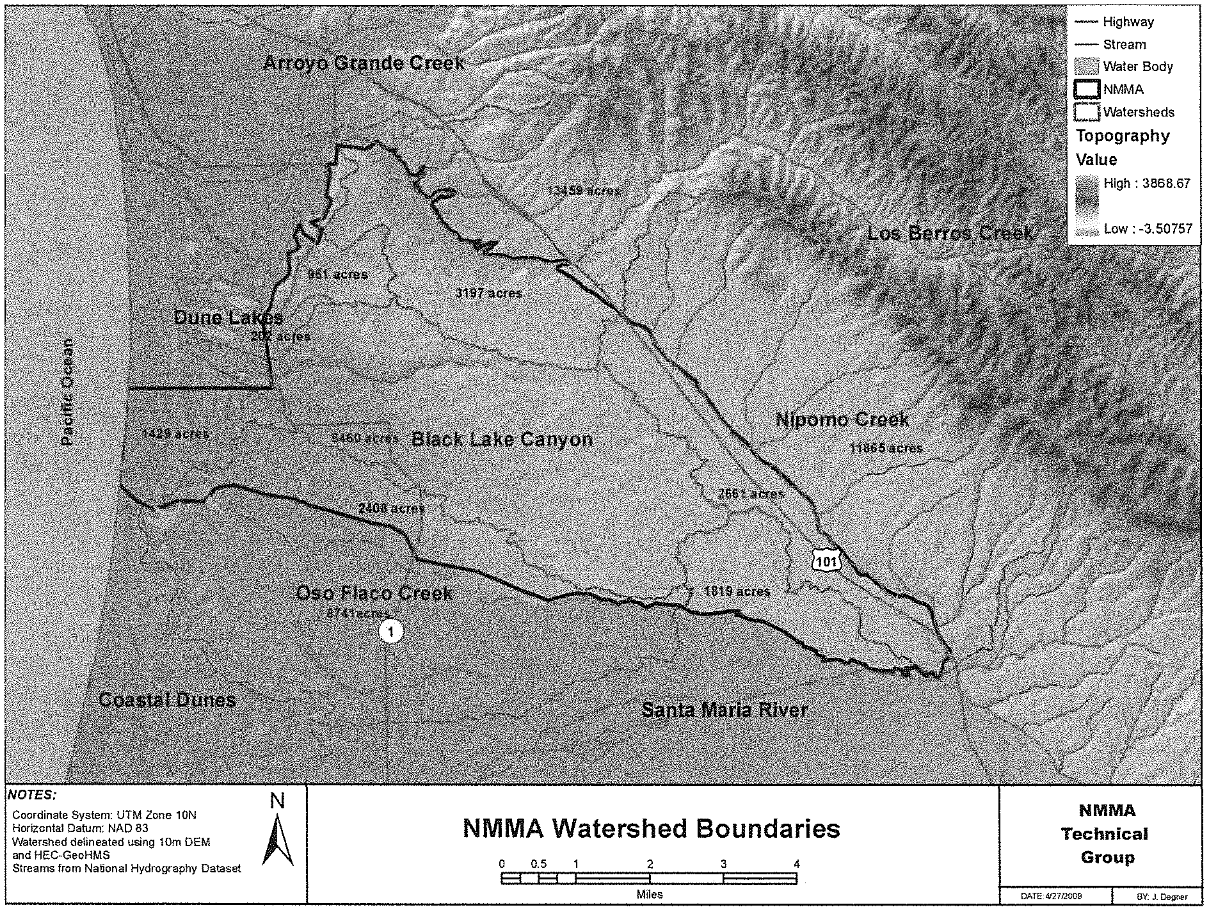

Figure 5-2. NMMA Watershed Boundaries

6. Groundwater Conditions

Groundwater conditions are principally characterized by measurements of groundwater elevations and groundwater quality, and interpretations such as groundwater elevation contours, groundwater gradients, and historical trends in elevations and water quality.

6.1. *Groundwater Elevations*

Groundwater elevations are analyzed using several methods. Hydrographs (graphs of groundwater elevation through time) for wells within and adjacent to the NMMA were updated through calendar year 2011. Hydrographs were constructed for a number of wells, particularly all the Key Wells. The Key Wells generally represent overall groundwater elevations of the principal production aquifers in the inland areas. In coastal monitoring wells, groundwater elevations were graphed for each well completion within a nested site to compare to sea level. Finally, the aggregate of groundwater elevation measurements was used to construct groundwater contour maps for the spring and fall of 2011.

6.1.1. Results from Inland Key Wells

Hydrographs were prepared for the Key Wells (Figure 6-1, Figure 6-2). Groundwater elevations in 2011 were above sea level in all Key Wells, though the trend in groundwater elevations varies. Groundwater elevations in the South-East and North-West portions of the NMMA have generally declined since about 2000, although there has been some flattening of the downward trend during the last three years. Groundwater elevations are generally within their historical range, although several of the Key Wells with long historical records are at or near their historical lows (e.g., well 11/35-13C1 [Figure 6-1]) and wells 12/35-33L1 and 11/35-5L1 [Figure 6-2]).

6.1.2. Results from Coastal Monitoring Wells

The elevation of groundwater in the coastal monitoring wells is very important because it is required to determine whether there is an onshore or offshore gradient to the ocean. In both coastal monitoring sites adjacent to the NMMA, groundwater elevations are above the criteria that defines the Potentially Severe Water Shortage Conditions (Figure 6-3, Figure 6-4). In spring 2011, the deeper well at site 12C had heads that were above ground surface.

6.1.3. Groundwater Contours and Pumping Depressions

Groundwater elevation data for the Deep Aquifers were plotted on two separate maps for Spring and Fall of 2011 and contour by hand. Groundwater elevation contours were constructed for both Spring and Fall of 2011 so that high and low groundwater conditions could be analyzed (Figure 6-5, Figure 6-6).

Spring 2011 contours represent a broadening of the pumping depression compared to 2010, as expressed by the 10 foot to 30 foot contours, and additionally show recharge to the aquifers coincident with the Los Berros Creek and Arroyo Grande Creek deposits along the north boundary of the NMMA. Fall 2011 contours represent a flattening of the groundwater elevations across the central NMMA expressed by the 10 foot contour and a broadening of the pumping depression compared to 2010, as expressed by the 0 foot contour. Notably, the pulse of recharge evident in the Spring 2011 contours has apparently migrated west to the coast as reflected in the 10 foot contour west of the dune lakes.

The most obvious feature in the contour maps is the pumping depression that has existed for decades within the north-central portion of the NMMA. Spring 2011 contours represent a broadening of the pumping depression from 2010 expressed by the 10 foot to 30 foot contours. Fall 2011 contours represent a flattening of the groundwater elevations across the central NMMA expressed by the 10 foot contour and a broadening of the main pumping depression expressed in the 0 foot contour.

The pumping depression trends in a northwest-southeast direction, parallel to the Santa Maria River and Oceano faults. DWR (2002) suggested that the Santa Maria River fault affected flow in the Deep Aquifers, with groundwater elevation contours offset by several tens of feet. However, the more-extensive groundwater elevation data set used in this Annual Report could not support this conclusion – the data are too variable from well to well in the eastern portion of the NMMA to detect offset of groundwater contours in the range of tens of feet.

Of interest is the area along the northwesterly boundary of the NMMA, adjacent to the Northern Cities Management Area. There continues to be a low-relief "saddle" between the NMMA and the Northern Cities Management Area to the north where groundwater elevations are a few feet higher near the boundary between the Management Areas. This saddle was reinforced in Spring 2011 as recharge to the aquifers occurred coincident with the Los Berros Creek and Arroyo Grande Creek deposits along the north boundary of the NMMA (Figure 6-5). It should also be noted that this report does not extend groundwater elevation contours to the east and southeast along Los Berros Creek because of the presence of a bedrock outcrop and the uncertainty in the hydrologic connection between shallow alluvial sediments along Los Berros Creek and the Deep Aquifers in the main portion of the basin.

Near the coastline, groundwater elevations within the NMMA are above sea level. As in earlier years, there is a ridge of higher groundwater elevations in the aquifers (groundwater elevations 10 feet to 20 feet above sea level) between coastal areas of the NMMA and the pumping depression in the north-central portion of the NMMA. Relief across this ridge of higher groundwater elevations was no more than 5 feet to 10 feet in Fall 2011. The highest elevation along the ridge is coincident with the Black Lake Canyon and west from where the Oceano fault crosses Black Lake Canyon. The persistence of this hydrologic feature is of interest to the TG, and further investigations regarding a local recharge zone are being considered.

The groundwater contours along the eastern portion of the NMMA are sub-parallel to the eastern NMMA boundary indicating flow southwest into the NMMA, suggesting that recharge may occur in this area. Besides the possibility of recharge from rainfall and seepage from adjacent older sediments along and to the east of the edge of the NMMA, Los Berros Creek flows across the shallow alluvium, which suggests local recharge may occur.

6.1.4. Groundwater Gradients

Groundwater gradients can be calculated directly from the groundwater elevation contour maps (Figure 6-5, Figure 6-6). The discussion of gradients is separated into coastal gradients that could affect potential seawater intrusion and gradients to/from adjacent management areas.

Coastal Gradients

In the coastal portions of the NMMA, there was an offshore gradient in both spring and fall of 2011 in the NMMA. This offshore gradient extends two to three miles inland, where it reverses to a landward gradient. The groundwater ridge between these opposing gradients is a transient feature formed because of the inland pumping depression, and may be in part supported by local recharge from Black Lake Canyon Creek and recharge through the Los Berros Creek and Arroyo Grande Creek deposits. Continued pumping at current rates in the depression could result in the elimination of the groundwater ridge, replaced by a landward gradient from the coastal monitoring wells all the way to the inland groundwater depression. If this were to occur, the current protection from possible seawater intrusion provided by the seaward groundwater gradient would be lost.

Gradients to/from Adjacent Management Areas

As discussed earlier in this section, the groundwater elevation contours between the NMMA and the Northern Cities Management Area consists of a saddle or divide in the groundwater elevations that separate the two management areas. The groundwater elevations near the divide are in the range of several feet higher than adjacent areas.

The northwest groundwater gradient along the southern boundary of the NMMA creates flow into the NMMA (Figure 6-5, Figure 6-6). This northwest gradient is limited to the area between the river and the NMMA boundary – it does not extend into the Santa Maria Valley on the south side of the river. Thus, the groundwater elevation beneath the river forms an effective boundary where groundwater flows toward the NMMA north of the river and into the main Santa Maria basin south of the river. This pattern of gradients suggests that the Santa Maria River is a source of supply to both management areas. If the

Deep Aquifers are confined in the area between the river and the NMMA boundary, then recharge from the river to the aquifers must be largely occurring up-gradient in places where no confining conditions exist.

6.2. *Groundwater Quality*

Water quality is a concern for all groundwater producers, although the specific concerns vary by water use. Water quality is somewhat different in different portions of the NMMA because:

- the source of recharge varies for different portions of the aquifer system,
- groundwater can develop different mineral signatures from the rock it flows through, and
- percolation of surface water mobilizes constituents of concern and carries these into the aquifers.

Water quality conditions in the NMMA during calendar year 2011 were relatively unchanged from 2010. The following sections describe coastal water quality and inland water quality conditions.

6.2.1. Results of Coastal Water Quality Monitoring

Quarterly coastal water quality monitoring within the NMMA boundary is currently limited to a single group of monitoring intervals at well 11N/36W-12C1, 2, 3, but the TG is also aware of published data for coastal water quality conditions in the NCMA. Limited historical water quality data are also available for other coastal monitoring wells to either side of the NMMA. Most chloride concentrations in the coastal wells are less than 100 mg/L, and do not show evidence of significant change over time (Figure 6-7). Coastal water quality monitoring at 11N/36W-12C1, 2 & 3 in 2011 also shows consistent results with respect to other common water quality characteristics such as TDS and electrical conductivity (specific conductance; Figure 6-8). Values for these constituents confirm relatively high dissolved ion content in groundwater, but at historically consistent values that are mostly within limits for existing uses.

6.2.2. Results of Inland Water Quality Monitoring

Water quality from inland wells is variable, both between wells (with similar groundwater elevations) and over time within a single well. Neither chloride nor total dissolved solids concentrations have experienced large temporal changes in samples from inland wells. In 2011, localized nitrate concentration measurements have been a cause for concern.

Nitrate: Elevated nitrate concentrations in groundwater generally result from anthropogenic causes. Nitrate is principally a potable water concern (as compared to a concern for irrigation water), with a primary drinking water standard of 45 mg/L (nitrate as NO_3, which is used throughout this report).

In calendar year 2011, nitrate concentration measurements within the principal aquifers were below the drinking water standard, except for one well in the northern area of the NMMA that exceeded the drinking water standard. A number of wells throughout the NMMA exhibit nitrate concentrations over half the drinking water standard.

Chloride: A primary concern for both drinking water and irrigation use is high chloride concentrations. Depending upon the crop, chloride concentrations well below the drinking water standard of 500 mg/L can cause leaf burn, plant stunting, and plant death. Elevated chloride concentrations can occur in groundwater from the recharge by return flows of water applied to overlying land uses, tidal waters, and shallow lakes, especially in unconfined aquifers.

In calendar year 2011, chloride concentrations were largely unchanged from the previous year, with 95 mg/l chloride or less for all groundwater samples obtained from the Deep Aquifers in the NMMA. Shallow wells near industrial and wastewater facilities have the highest chloride concentrations, but the concentrations are below the water quality standards.

Total Dissolved Solids (TDS): In calendar year 2011, TDS concentrations were similar to 2010 results. Based on limited sampling in calendar year 2011, all Deep Aquifer production and monitoring wells contained TDS at or below 1,100 mg/l, with most wells below 900 mg/l. Groundwater samples from several shallow wells contained total dissolved solids at or above the 1,000 mg/l California recommended secondary standard for TDS. The NMMA TG will continue to monitor the water quality of these wells.

Hydrocarbons. Several local sites of known or potential soil and shallow groundwater contamination are described by environment assessments or ongoing remediation and monitoring activity at sites within the NMMA. These sites are associated with an oil pipeline along Nipomo Creek and a gas station in the eastern portion of the NMMA. The sites are in various stages of assessment or corrective action and are regulated by the RWQCB or other state agencies. Four sites are currently undergoing study or remedial action in the NMMA (see Table 6-1 below).

Table 6-1. State Water Resources Control Board GeoTracker Active Sites

Site Name	Address	Status	Notes
Chevron Station 9-5867	460 West Tefft St	Open; Site Assessment	Leaking underground tank site. In 1998, a release of gasoline was discovered impacting soil.
Nipomo Creek Pipeline, Line 300	671 Oakglen Ave	Open; Remediation	Petroleum hydrocarbon impacted soil and shallow groundwater adjacent to petroleum pipeline at two sites approximately ½ mile apart. Corrective Action Plan was approved in 2010. Removal of impacted soil continued during 2011.
ConocoPhillips, Line 300	Tefft St at Carillo St intersection	Open; Site Assessment	Petroleum hydrocarbon impacts to soil and shallow groundwater adjacent to two petroleum pipelines (ConocoPhillips & Unocal). Site assessment and work plan development ongoing in 2011.
ConocoPhillips Refinery, Santa Maria Facility	2555 Willow Rd	Open; Site Assessment	Case opened in 1999 to investigate potential soil and shallow groundwater impacts from a coke pile area. Groundwater monitoring ongoing in 2011.
Source: http://geotracker.swrcb.ca.gov			

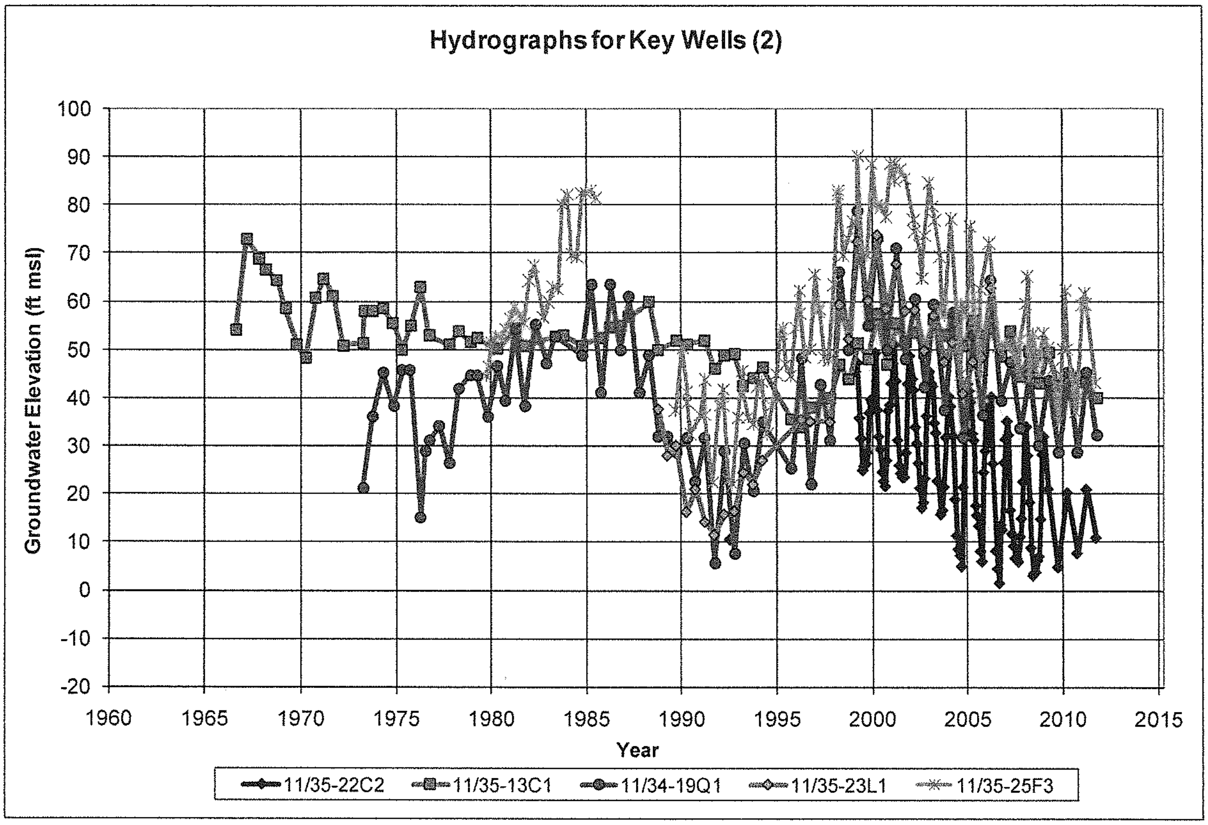

Figure 6-1. Key Wells Hydrographs, South-East Portion of NMMA. Note: Lines between data values are included to track the sequence of points and do not represent measurements.

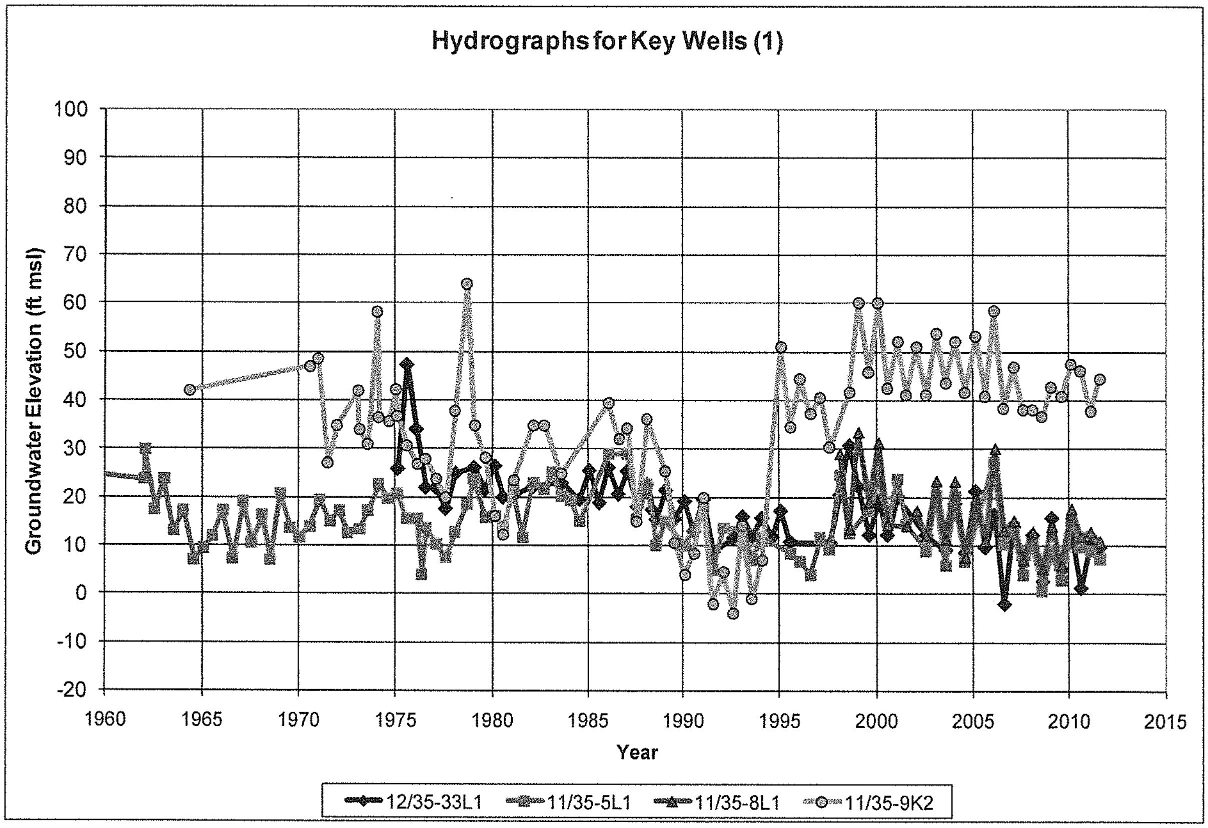

Figure 6-2. Key Wells Hydrographs, North-West Portion of NMMA

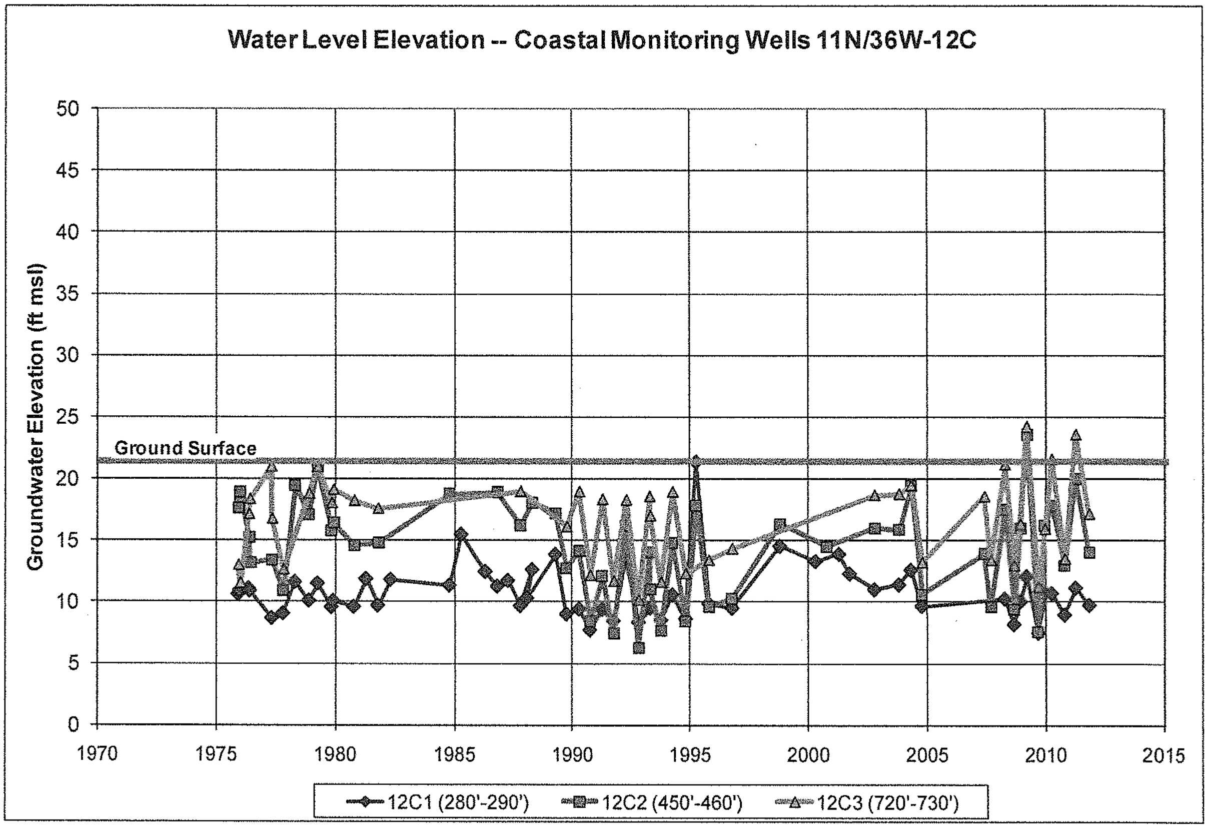

Figure 6-3. Hydrograph for Coastal Monitoring Well Clusters 11N/36W-12C. Note: Water levels measured under artesian flow prior to 2008 were observed without measuring the hydraulic head and recorded as a default value of 2 feet above the casing.

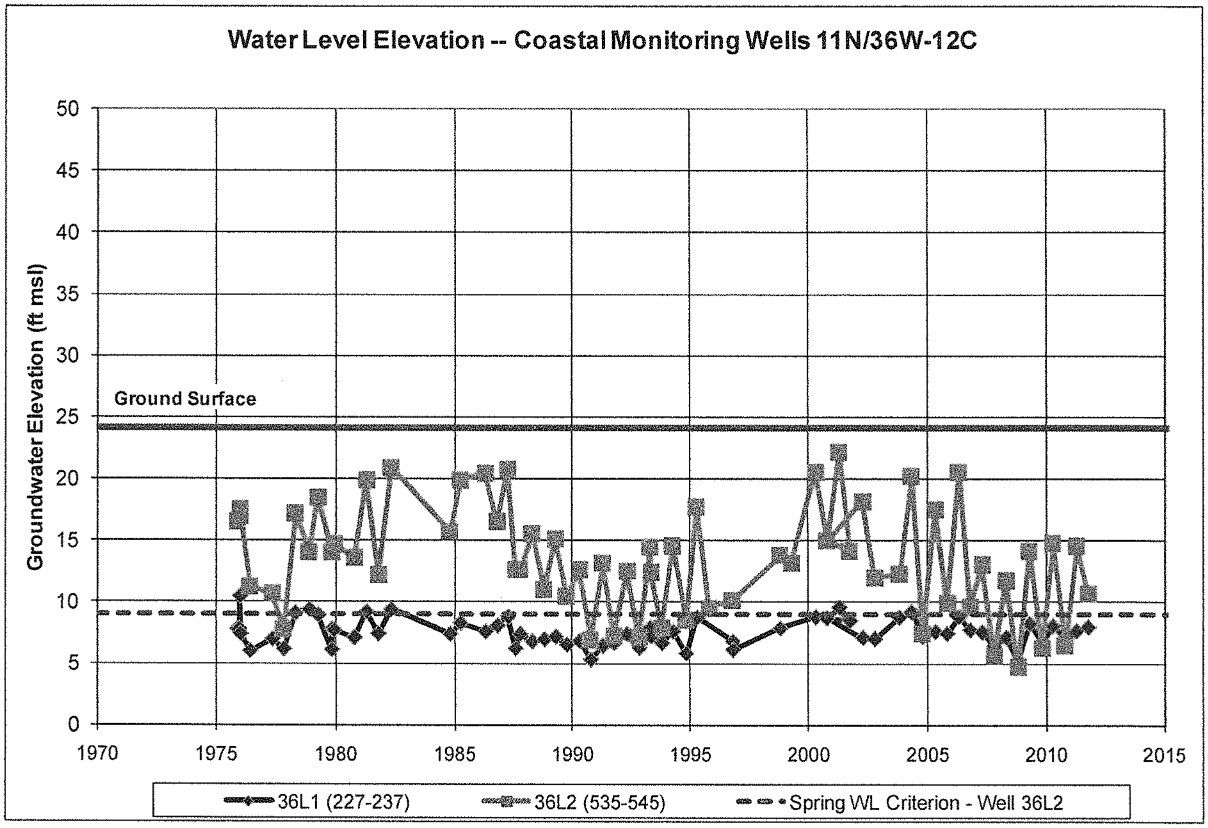

Figure 6-4. Hydrograph for Coastal Monitoring Well Clusters 12N/36W-36L

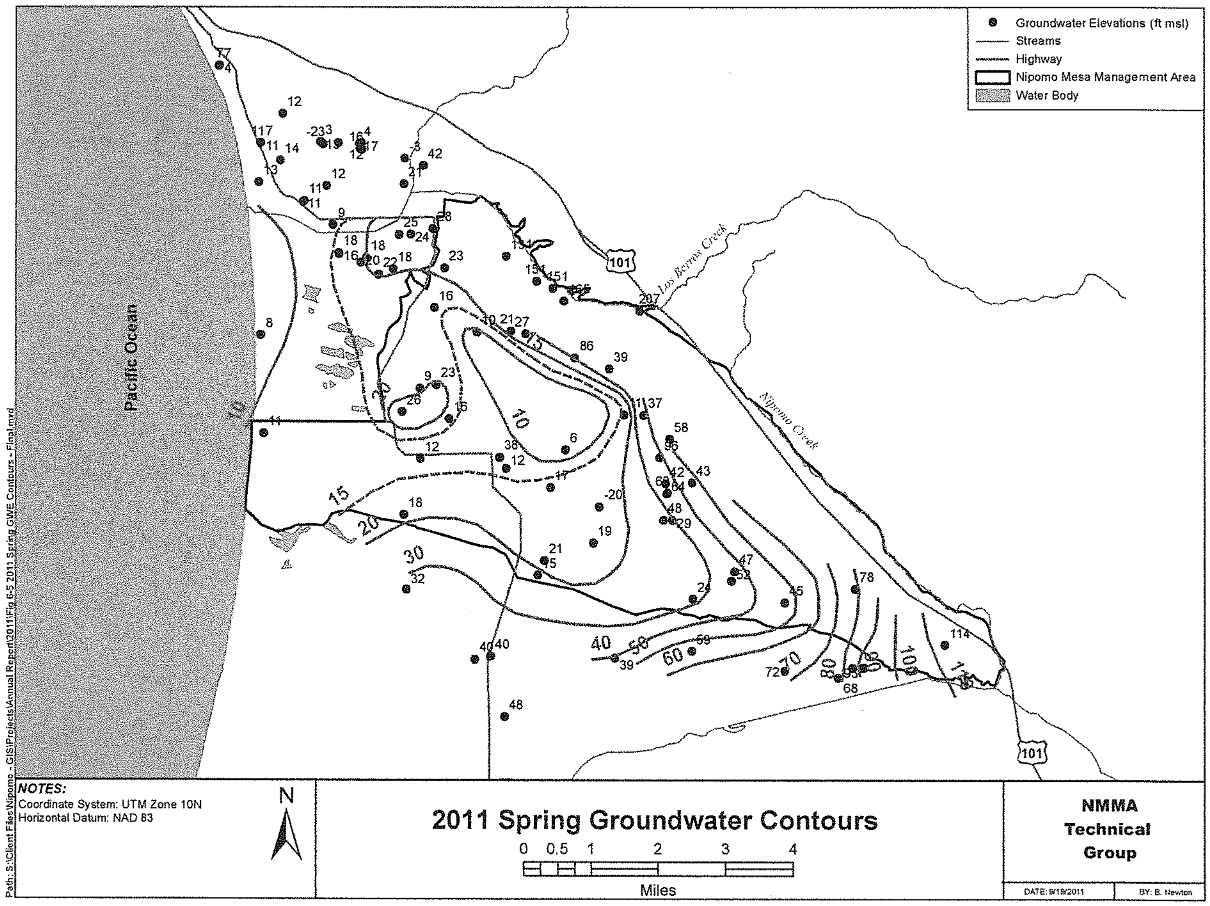

Figure 6-5. 2011 Spring Groundwater Contours

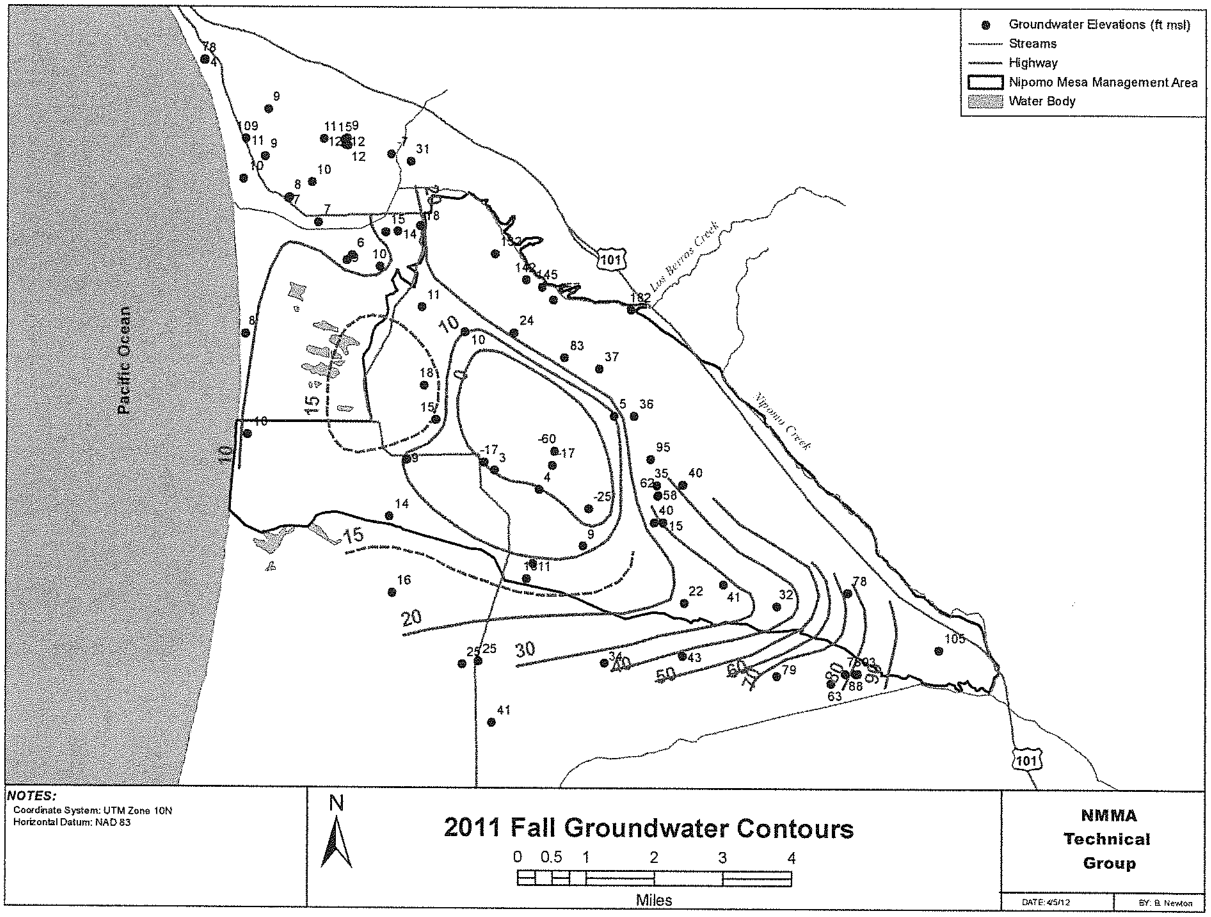

Figure 6-6. 2011 Fall Groundwater Contours

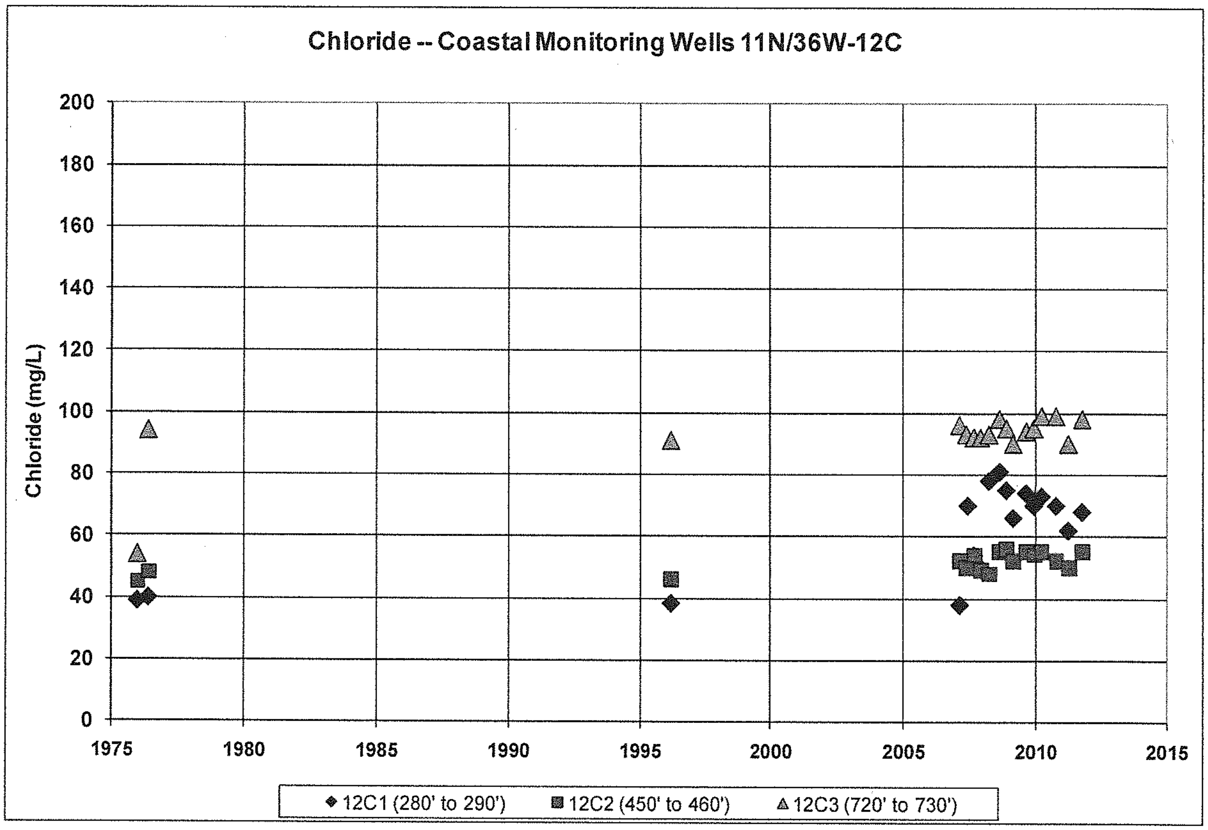

Figure 6-7. Chloride in Coastal Well 11N/36W-12C

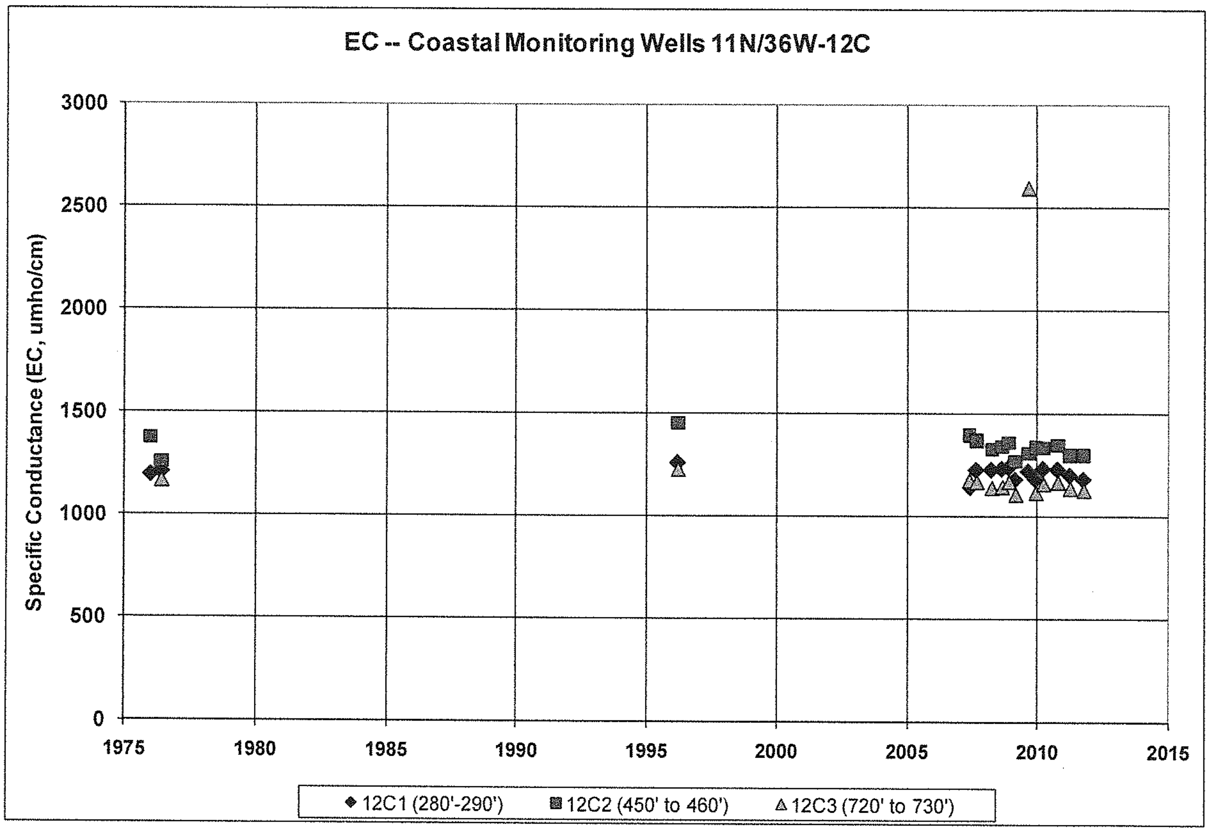

Figure 6-8. Electrical Conductivity in Coastal Well 11N/36W-12C

7. Analyses of Water Conditions

Current groundwater conditions, water shortage conditions, and long-term trends are presented in the following sections, with emphasis on the primary areas of concern.

7.1. *Current Conditions*

7.1.1. Groundwater Conditions

The primary areas of focus in evaluating the conditions of groundwater within the NMMA are: 1) groundwater elevations and water chemistry of coastal monitoring wells, 2) the coastal groundwater gradient, 3) the overall groundwater elevations within the NMMA, as measured by the Key Wells Index, and 4) the extent of the pumping depression.

Coastal Monitoring Wells – Both groundwater elevations and chloride concentrations in the coastal well cluster within the NMMA have been stable for some years. However, groundwater elevations in the coastal well cluster 36L have declined the last decade (Figure 6-4).

Coastal Groundwater Gradient – There is currently a westward component of flow toward the ocean beneath the coastal dunes, separated from the inland groundwater depression by a transient groundwater divide (See Section 6.1.4 Groundwater Gradients). If the inland groundwater depression continues to expand, a landward gradient from the coastal monitoring wells to the inland groundwater depression may develop. In Spring and Fall 2011, the coastal gradient near Black Lake was towards the offshore with a slight northward component of flow that is more pronounced in the fall.

Key Wells Index – The Key Wells Index indicates trends in groundwater elevations within inland areas of the NMMA, and is intended to reflect whether there is a general balance between inflows and outflows in the NMMA. The 2011 Key Well Index declined sharply from 2010, even though rainfall was 180 percent of long-term average conditions and percolation past the root zone was 12,296 AF, roughly two times the typical amount. Groundwater elevations in several of the wells that make up the Key Wells Index have generally declined since about 2000, whereas groundwater elevations in some of these wells have increased over the past two to three years (see Section 6.1.1 Results from Inland Key Wells). The 2011 Key Wells Index value remains below the threshold criterion for Potentially Severe conditions (Figure 7-2).

Pumping Depression – The groundwater depression within the inland portion of the NMMA was evident in both Spring and Fall 2011 groundwater elevation contours (Figure 6-5, Figure 6-6). This depression creates a transient groundwater divide between both coastal areas and the Northern Cities Management Area. If this groundwater depression widens to the west or lengthens to the north, the groundwater divide may be breached, allowing groundwater flow from coastal areas to the groundwater depression. This potential reversal of groundwater gradients could create conditions for seawater intrusion. Thus, the TG will carefully research it for future reports in cooperation with the Northern Cities Management Area TG.

The other effect of the groundwater depression could be compaction and dewatering of fine-grained sediments within and adjacent to the aquifers of the NMMA, with subsequent land subsidence. There is currently no evidence of land subsidence within the NMMA, although small amounts of subsidence might go undetected. During dewatering and compaction, it is typically the finer grained sediments that are most impacted rather than the main water-producing horizons.

7.1.2. Hydrologic Inventory

The hydrologic inventory is currently incomplete due to the TG developing an improved understanding of subsurface flow across the NMMA boundaries. Although the hydrologic inventory cannot be used directly to calculate the potential imbalance between inflow and outflow for calendar year 2011, there are a number of observed conditions that indicate that outflow exceeds the ability of the inflow to replace this water pumped from the aquifers. These indicators include: 1) continued presence of the pumping depression in the NMMA, a portion of which is below sea level; 2) a limited component of seaward flow at the coast; 3) a flattening of the groundwater ridge between coastal and inland wells that protects inland areas from potential seawater intrusion; and 4) a threat on the north by the occurrence of seawater intrusion in the Deep Aquifers.

7.2. *Water Shortage Conditions*

The Stipulation requires the determination of the water shortage condition as part of the Annual Report. Water shortage conditions are characterized by criteria designed to reflect that groundwater levels beneath the NMMA as a whole are at a point at which a response would be triggered to avoid further declines in groundwater levels (Potentially Severe), and to declare that the lowest historic groundwater levels beneath the NMMA as a whole have been reached or that conditions constituting seawater intrusion have been reached (Severe). Potentially Severe Water Shortage Conditions exist in calendar year 2011.

Potentially Severe Water Shortage Conditions

The Stipulation, page 25, defines Potentially Severe Water Conditions as follows:

Caution trigger point (Potentially Severe Water Shortage Conditions)

(a) Characteristics. The NMMA Technical Group shall develop criteria for declaring the existence of Potentially Severe Water Shortage Conditions. These criteria shall be approved by the Court and entered as a modification to this Stipulation or the judgment to be entered based upon this Stipulation. Such criteria shall be designed to reflect that water levels beneath the NMMA as a whole are at a point at which voluntary conservation measures, augmentation of supply, or other steps may be desirable or necessary to avoid further declines in water levels.

Severe Water Shortage Conditions

The Stipulation, page 25, defines Severe Water Conditions as follows:

Mandatory action trigger point (Severe Water Shortage Conditions)

(a) Characteristics. The NMMA Technical Group shall develop the criteria for declaring that the lowest historic water levels beneath the NMMA as a whole have been reached or that conditions constituting seawater intrusion have been reached. These criteria shall be approved by the Court and entered as a modification to this Stipulation or the judgment to be entered based upon this Stipulation.

7.2.1. Coastal Criteria

All coastal groundwater elevation and water quality criteria for Water Shortage Conditions are at acceptable levels (Table 7-1).

Table 7-1. Criteria for Potentially Severe Water Shortage Conditions

Well	Perforations Elevations (ft msl)	Aquifer	Spring 2011 Elevations (ft msl)	Elevation Criteria (ft msl)	2011 Highest Chloride (mg/L)	Chloride Concentration Criteria (mg/L)
11N/36W-12C1	-261 to -271	Paso Robles	11.1	**5.0**	68	**250**
11N/36W-12C2	-431 to -441	Pismo	20.2	**5.5**	55	**250**
11N/36W-12C3	-701 to -711	Pismo	23.6	**9.0**	98	**250**
12N/36W-36L1	-200 to -210	Paso Robles	7.8	**3.5**	-	**250**
12N/36W-36L2	-508 to -518	Pismo	14.7	**9.0**	-	**250**

7.2.2. Inland Criteria

The inland criteria for Water Shortage Conditions use the Key Wells Index as a basis. The Spring 2011 Key Wells Index was 25.3 ft msl, at a lower elevation than the criterion for Potentially Severe Water Shortage Conditions of 31.5 ft msl, and sharply declined from the Key Wells Index for 2010 (Figure 7-2).

7.2.3. Status of Water Shortage Conditions

The Key Wells Index went below the elevation criterion for Potentially Severe Water Shortage Conditions with the Spring 2008 water level measurements, and has remained so through to Spring 2011. Exiting the Potentially Severe Water Shortage Conditions requires two consecutive years where the Key Wells Index is above the level of Potentially Severe Water Shortage Condition.

The responses required by the Stipulation are set forth as follows:

VI(D)(1b) Responses [Potentially Severe]. *If the NMMA Technical Group determines that Potentially Severe Water Shortage Conditions have been reached, the Stipulating Parties shall coordinate their efforts to implement voluntary conservation measures, adopt programs to increase the supply of Nipomo Supplemental Water if available, use within the NMMA other sources of Developed Water or New Developed Water, or implement other measures to reduce Groundwater use.*

VI(A)(5). …In the event that Potentially Severe Water Shortage Conditions or Severe Water Shortage Conditions are triggered as referenced in Paragraph VI(D) before Nipomo Supplemental Water is used in the NMMA, NCSD, [GSWC], Woodlands and RWC agree to develop a well management plan that is acceptable to the NMMA Technical Group, and which may include such steps as imposing conservation measures, seeking sources of supplemental water to serve new customers, and declaring or obtaining approval to declare a moratorium on the granting of further intent to serve or will serve letters.

Nipomo Mesa groundwater management options to address water shortage conditions include responses required under the Stipulation as well as other possible groundwater management actions to address a range of resource concerns associated with the current Potentially Severe Water Shortage Condition. TG concerns directly relating to groundwater conditions include:

- Depressed groundwater elevations, both as measured by the Key Wells Index and in specific portions of the management area;
- Very limited offshore gradient for a large area of the coastal and central portions of the NMMA;
- Very limited gradient separating the management area with the coastal area of seawater intrusion to the north.

Potential actions to address the above concerns include a range of projects and activities already in place, in progress, or contemplated for future consideration. Many of these possibilities have been reviewed previously in water supply evaluations (SAIC, 2006; Kennedy-Jenks, 2001; Bookman-Edmonston, 1994).

<u>Existing Actions in the NMMA reviewed by the TG include</u>

- Adoption in calendar year 2010 of a purveyor Well Management Plan, which includes conservation, public outreach, and facilities upgrades to allow greater distribution of pumping stresses away from areas of concern (see Section 1.1.6 Well Management Plan)
- Continued progress in 2011 on a NSWP (see Section 1.1.7 Supplemental Water)

<u>Potential actions to be reviewed by the TG include</u>

- Increased development of reclaimed water for certain NMMA water supply needs in lieu of pumping from the Deep Aquifers.

Different management options have different potential capacity to reduce demand or increase supply, and each has its own technical considerations. By way of example and assuming regulatory agency approval and the establishment of an appropriate cost benefit that meets the requirements of Prop 218 or the PUC, wastewater effluent that is not already reclaimed may be discharged in locations where wastewater effluent would have a beneficial effect on the deep aquifers and in areas closer to the coast.

Areas of special concern with regard to potential shortage conditions have special significance if they experience beneficial results from projects to manage groundwater demands and overall supply. For example, the coastal portion of the NMMA has a limited component of seaward flow, and is threatened on the north by the occurrence of seawater intrusion in the Deep Aquifers. Actions that maintain a healthy ocean-ward component of flow protect the basin from potential seawater intrusion. Similarly, the pumping depression in the central portion of the NMMA has transient groundwater levels below sea level and is a pronounced feature of the main producing aquifers in the NMMA (see Figures 6-5 and 6-6). Allowing water levels to rebound in this area would also help to maintain protective groundwater gradients.

7.3. *Long-term Trends*

Long-term trends in climate, land use, and water use are presented in the following sections.

7.3.1. Climatological Trends

Climatological trends have been identified through the use of cumulative departure from mean analyses. A cumulative departure from the mean represents the accumulation, since the beginning of the period of record, of the differences (departures) in annual total rainfall volume from the mean value for the period of record. Each year's departure is added to or subtracted from the previous year' cumulative total, depending on whether that year's departure was above or below the mean annual rainfall depth. When the slope of the cumulative departure from the mean is negative (i.e. downward), the sequence of years is drier than the mean, and conversely when the slope of the cumulative departure from the mean is positive (i.e. upward), the sequence of years is wetter than the mean. The cumulative departures from the mean were computed for the rainfall station Mehlschau (38), the longest rainfall record for the NMMA (Figure 7-3).

Historical rainfall records for the Nipomo Mesa begin in 1920. There are three significant long-term dry periods in the record, from 1921 to 1934, from 1944 to 1951, and from 1984 to 1991. Long-term dry periods have occurred in the last 90 years that are longer in duration than the 1987 to 1992 drought (Figure 7-3). Between each large dry period, three wetting periods have occurred. These wetting periods are from 1935 to 1943, from 1977 to 1983, and from 1994 to 2001.

The period of analyses (1975-2011) used by the TG is roughly 11 percent "wetter" on average than the long-term record (1920-2011) indicating a slight bias toward overestimating the amount of local water supply resulting from percolation of rainfall. The Water Years 2007, 2008, and 2009 have had less than average rainfall. Water Year 2007 was approximately 45 percent to 50 percent of average rain fall, Water Year 2008 was approximately 94 percent to 97 percent of average rain fall, and Water Year 2009 was approximately 67 percent to 73 percent of average rain fall. For the past two years, (WY 2010 and WY2011), rainfall was approximately 130 percent and 180 percent of average conditions (Table 3-1).

7.3.2. Land Use Trends

The DWR periodically has performed land use surveys of the South Central Coast, which includes the NMMA, in 1958, 1969, 1977, 1985, and 1996. A land use survey for only the NMMA was performed in 2007 based on 2007 aerial photography (See Section 3.1.8 Land Use). Based on these surveys, land use in the NMMA has changed dramatically over the past half-century (Table 7-2, Figure 7-4, and Figure 7-5). Urban development has replaced native vegetation at an increasing rate, especially over the past 10 years. Agriculture land use has remained relatively constant (see Section 3.1.8 Land Use).

Table 7-2. NMMA Land Use – 1959 to 2007 (acres)

	1959	1968	1977	1985	1996	2007
Agricultural	1,600	2,000	2,000	2,200	2,000	2,600
Urban	300	700	2,200	3,300	5,800	10,200
Native	19,200	18,400	16,900	15,600	13,300	8,300
Total	21,100	21,100	21,100	21,100	21,100	21,100

7.3.3. Water Use and Trends in Basin Inflow and Outflow

DWR (2002) estimated the Dependable Yield (DWR, 2002. Page ES21) for their study area to be between 4,800 and 6,000 AF/yr. Their study area is approximately equivalent to the NMMA.

The estimated groundwater production is 10,538 AF for calendar year 2011, which is about two and one half times the groundwater production in 1975 (Figure 4-1), confirming a trend of increased groundwater production over the last 35 years or so. The estimated consumptive use of water for urban, agricultural and golf course, and industrial use for calendar year 2011 is 8,308 AF. Contours of groundwater elevations in this report suggest that there is likely inflow from the Santa Maria Valley Management Area, outflow at the coast (required to prevent seawater intrusion), and subsurface flow into or out of the Northern Cities Management Area. The net subsurface flow to the NMMA is therefore likely to be positive.

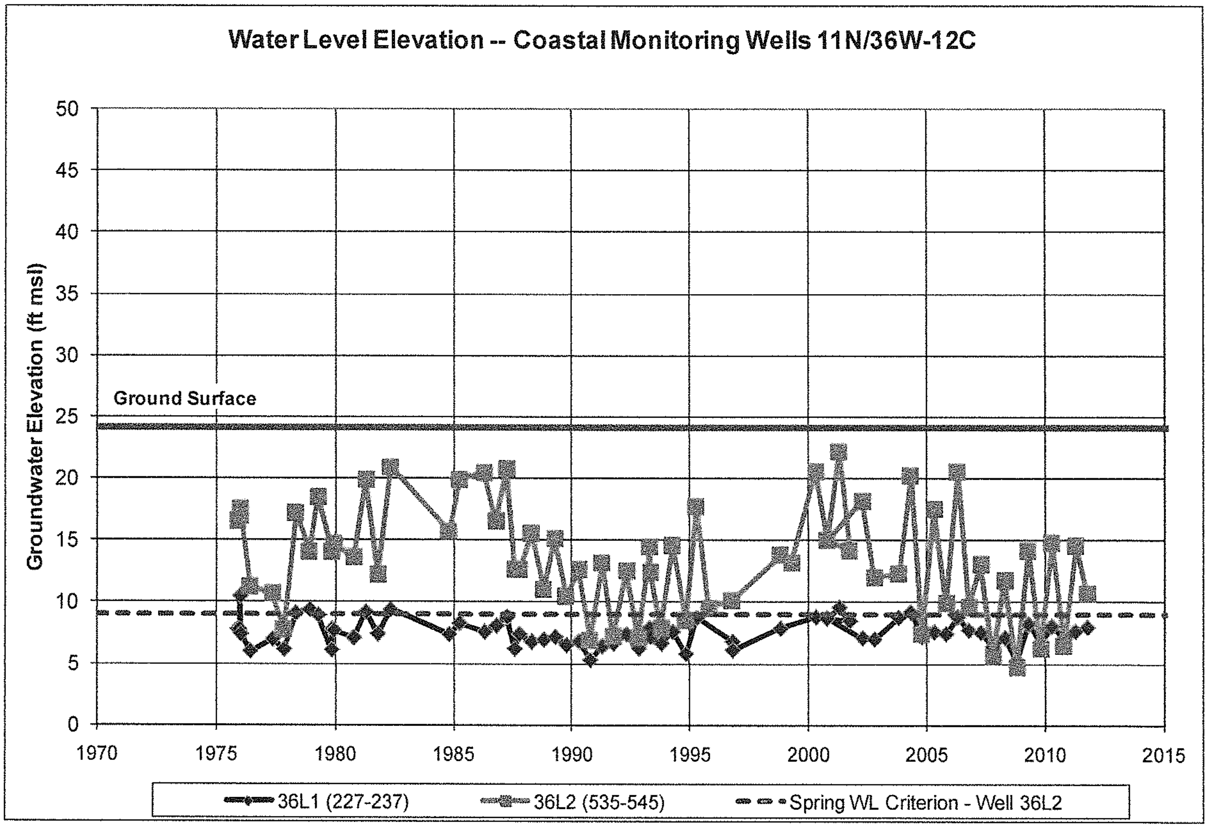

Figure 7-1. Coastal monitoring well cluster 36L. *The criterion for Potentially Severe Water Shortage Conditions for well 36L2 indicated by dashed line.*

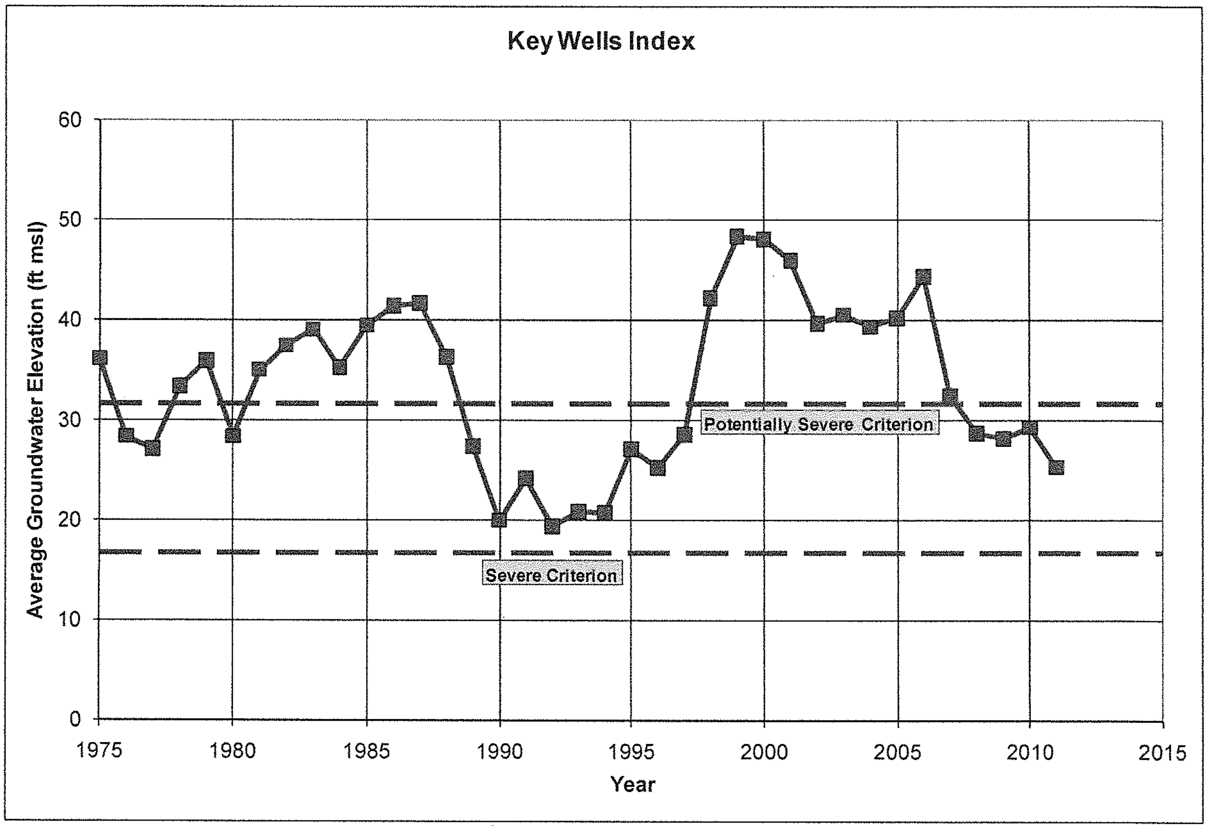

Figure 7-2. Key Wells Index. *The upper dashed line is the criterion for Potentially Severe Water Shortage Conditions and the lower dashed line is the criterion for Severe Water Shortage Conditions.*

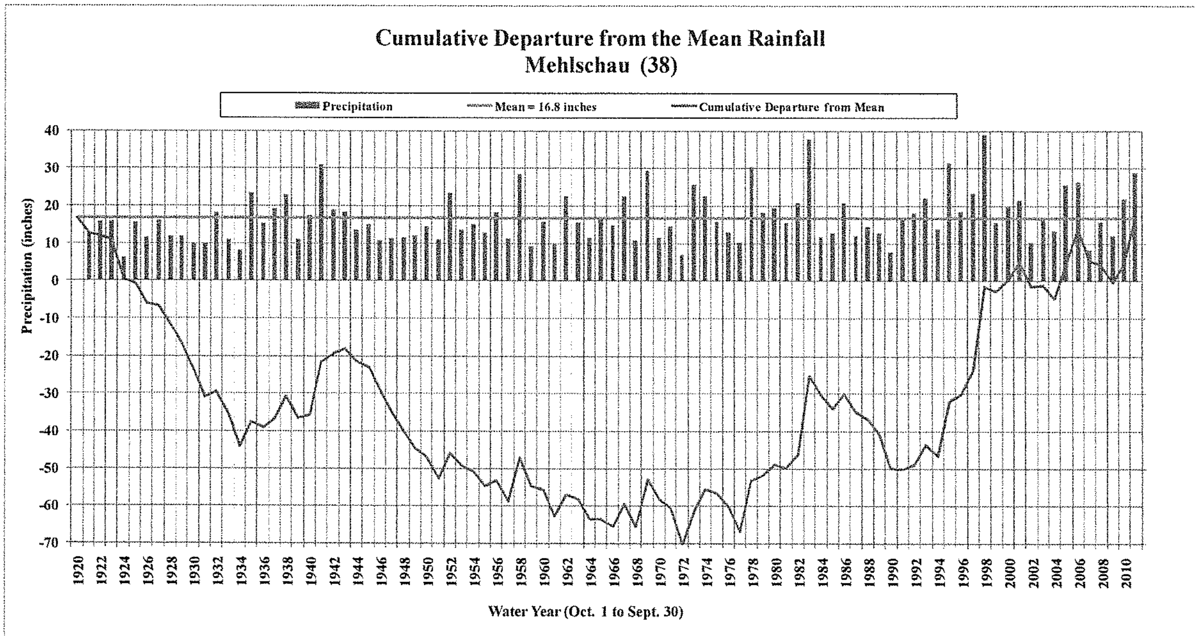

Figure 7-3. Rainfall: Cumulative Departure from the Mean – Rainfall Gauge Mehlschau (38)

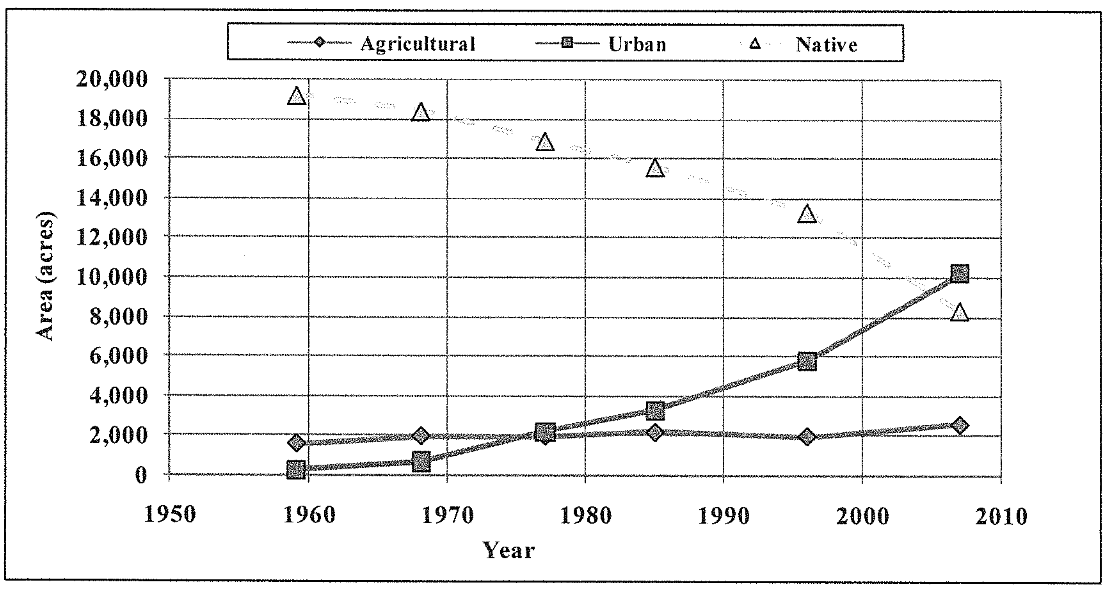

Figure 7-4. NMMA Land Use – 1959 to 2007

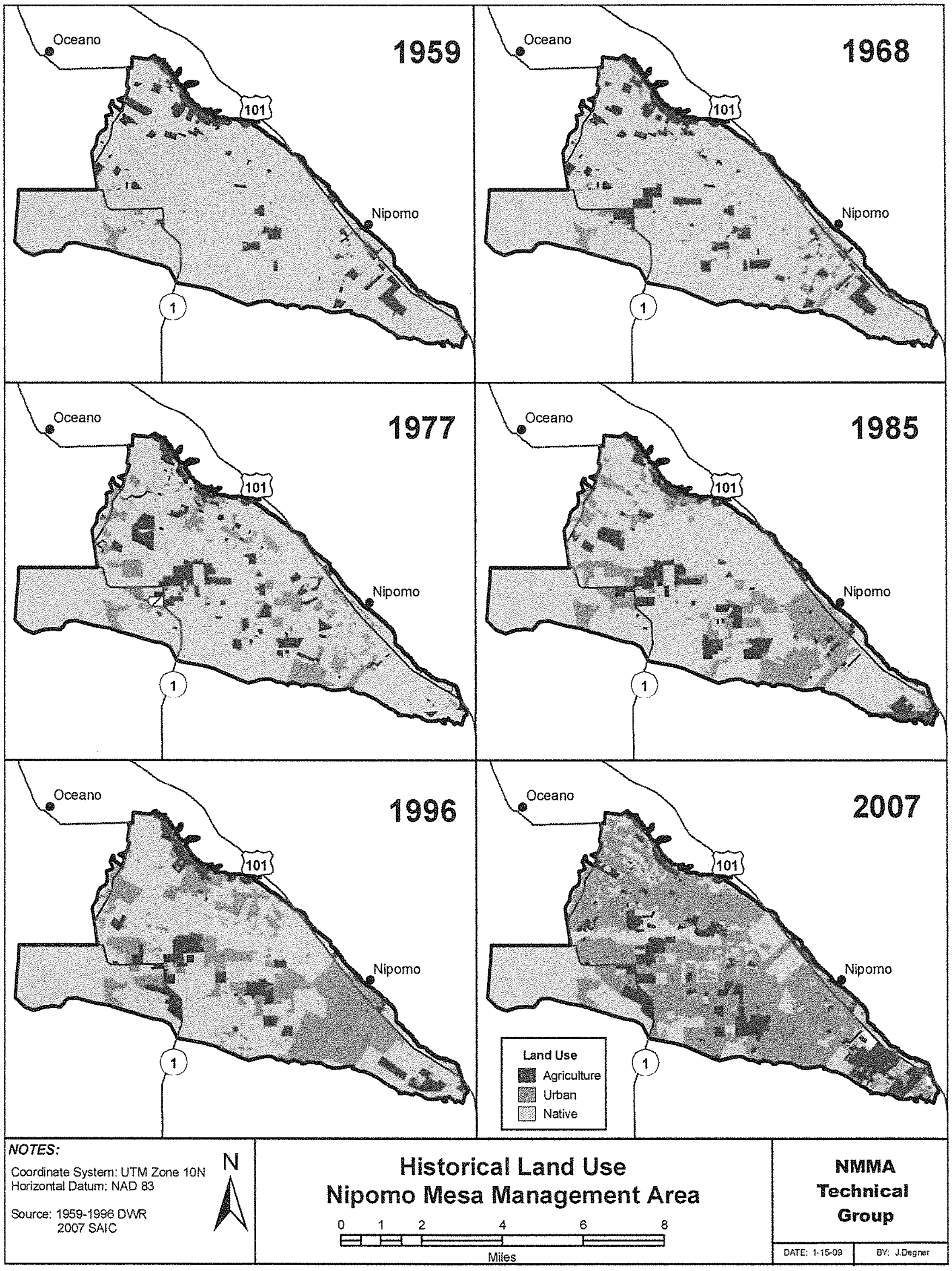

Figure 7-5. Historical Land Use in the NMMA

8. Other Considerations

8.1. *Institutional or Regulatory Challenges to Water Supply*

Several types of entities and individual landowners extract water from aquifers underlying the NMMA to meet water demands and no single entity is responsible for the delivery and management of available water supplies. Each entity must act in accordance with the powers and authorities granted under California law.

The powers and authorities for the Woodlands Mutual Water Company and Nipomo Community Services District are set forth in the California Water Code. The CPUC regulates Golden State Water Company's and Rural Water Company. This diversity of the public water purveyors' powers and the locations of their respective service areas (Figure 1-1) must be taken into account in attempting to develop consistent water management strategies that can be coupled with enforceable measures to ensure timely compliance with recommendations made by the TG, or mandatory Court orders. This is particularly true when there are legal requirements relating to the timing of instigating changes in water rates, implementation of mandatory water conservation practices or forcing a change in pumping patterns which may require one entity to deliver water to a location outside its service area.

A cooperative effort among the purveyors and other parties is the only expedient means to meet these institutional and regulatory challenges relating to the water supply and overall management of the NMMA. The purveyors developed a Well Management Plan (WMP) in calendar year 2010 which outlines steps to take in "potentially severe water shortage conditions" as well as in "severe water shortage conditions"[1]. The WMP identifies a list of recommended water use restrictions to limit prohibited, nonessential and unauthorized water uses. For each condition, the WMP also identifies both voluntary and mandatory actions such as conservation goals, shifts in pumping patterns, and potential additional use and pumping restrictions. NCSD is developing the engineering design of the NSWP, which will provide for the delivery of supplemental water within the NMMA.

9. Recommendations

A list of recommendations were developed and published in each of the previous NMMA Annual Reports. The TG will address past and newly developed recommendations along with the implementation schedule based on future budgets, feasibility, and priority. The recommendations are subdivided into three categories: (1) Draft capital and operation expenditure plan, (2) Achievements from earlier NMMA Annual Report recommendations accomplished in 2011; and (3) Technical Recommendations – to address the needs of the TG for data collection and compilation.

9.1. *Funding of Capital and Operating Expenditure Program*

The TG acknowledges that the work items and budget presented below represent a consensus view that additional technical work is necessary beyond that covered under the current annual budget

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[1] See Appendix B- "NMMA Water Shortage Conditions and Response Plan" which defines these conditions.

limit. Completing this broader scope of work will require a formal adjustment to the NMMA TG budget limit.

Table 9-1. NMMA 5-Year Cost Analysis

Task Description	Total Cost	Targeted Completion Year	Projected 5-year Cash Flow				
			2012	2013	2014	2015	2016
Yearly Tasks							
Annual Report preparation			$50,000	$50,000	$50,000	$50,000	$50,000
Grant funding efforts			$10,000	$10,000	$10,000	$10,000	$10,000
Confining layer definition			$10,000	$10,000	$10,000	$10,000	$10,000
Well head surveying			$3,000	$3,000	$3,000	$3,000	$3,000
Analytical testing			$5,000	$5,000	$5,000	$5,000	$5,000
Long Term Studies							
Groundwater model (NMMA share)	$250,000	2016	$33,300	$33,300	$33,300	$75,000	$75,000
Capital Projects							
Oso Flaco monitoring well	$130,000	2014	$43,300	$43,300	$43,300	- -	- -
Automatic monitoring equipment	$25,000	2016	- -	- -	- -	$12,500	$12,500
Total Projected Annual Cost			$154,600	$154,600	$154,600	$165,500	$165,500

9.2. *Achievements from previous NMMA Annual Report Recommendations*

The TG worked diligently to address several of the recommendations outlined in the previous Annual Reports. Accomplishments and/or progress made during 2011 include:

- Development of refined cross-sections through key areas of the basin,
- Reviewed and identified existing well locations and recommended additional monitoring to be incorporated into the County water level monitoring program, and
- Met with representatives from Northern Cities Management Area and Santa Maria Valley Management Area to discuss groundwater modeling possibilities, groundwater monitoring activities, methodology to estimate percolation, and sea water intrusion findings.

9.3. *Technical Recommendations*

The following technical recommendations are not organized in their order of priority, because the monitoring parties, considering their own particular funding constraints and authorities, will determine the implementation strategies and priorities. However, the TG has suggested a priority for some of the technical recommendations.

- **Supplemental Water Supply** – An additional water supply that would allow reduced pumping within the NMMA is the most effective method of reducing the stress on the aquifers and allow groundwater elevations to recover. The NSWP (see Section 1.1.7-Supplemental Water) is the fastest method of obtaining alternative water supplies. Given the Potentially Severe Water

Shortage Conditions within the NMMA and the other risk factors discussed in this Report, the TG recommends that this project be implemented as soon as possible.

- **Subsurface Flow Estimates** – Continue to develop and evaluate geologic cross-sections along NMMA boundaries and make estimates of subsurface flow.

- **Severe Water Shortage Conditions** – The TG will evaluate the potential mandatory responses to the Severe Water Shortage Conditions as prescribed in the Stipulation Paragraph VI(D)(1b)(i)-(v).

- **Installation of Groundwater Monitoring Equipment** – When a groundwater level is measured in a well, both the length of time since the measured well is shut off and the effect of nearby pumping wells modify the static water level in the well being measured. For the Key Wells, the installation of transducers and data loggers will largely solve this problem. Installation of transducers is also recommended for purveyors' wells that pump much of the time.

- **Changes to Monitoring Points or Methods** – The coastal monitoring wells are of great importance in the Monitoring Program. The inability to locate the monitoring well cluster under the sand dunes proximally north of Oso Flaco Lake renders the southwestern coastal portion of the NMMA without adequate coastal monitoring. During 2009 and 2010, the NMMA TG reviewed options for replacing this lost groundwater monitoring site. The TG was given written support of the concept from the State Parks Department to allow replacement of the well, and the TG has also had discussions with San Luis Obispo County, which may be able to provide some financial assistance for the project. The NMMA TG has incorporated replacement of this monitoring well in its long-term capital project planning and will investigate possible State or Federal grants for financial assistance with the construction of this multi-completion monitoring well.

- **Well Management Plan** – It is recommended that for calendar year 2012, purveyors compile and present to the TG a Well Management Plan status update.

- **County of San Luis Obispo Monitoring Locations** – Review proposed County of San Luis Obispo monitoring well and stream gauge locations.

- **Well Reference Point Elevations** – It is recommended that all the wells used for monitoring have an accurate RP elevation established over time. This could be accomplished by surveying a few wells every year or by working with the other Management Areas and the two counties in the Santa Maria Groundwater Basin to obtain LIDAR data for the region; the accuracy of the LIDAR method allows one-foot contours to be constructed and/or spot elevations to be determined to similar accuracy.

- **Groundwater Production** – Estimates of total groundwater production are based on a combination of measurements provided freely from some of the parties, and estimates based on land use. The TG recommends developing a method to collect groundwater production data from all stipulating parties. The TG recommends updating the land use classification on an interval commensurate with growth and as is practical with the intention that the interval is more frequent than DWR's 10-year cycle of land use classification.

- **Increased Collaboration with Agricultural Producers** – To better estimate agricultural groundwater production where data is incomplete, it is recommended that the TG work with a subset of farmers to measure groundwater production. This measured groundwater production can then be used to calibrate models and verify estimates of agricultural groundwater production where data are not available.

- **Hydrogeologic Characteristics of NMMA** – Further defining the continuity of confining conditions within the NMMA remains a topic of investigation by the TG. The locations of confined and unconfined conditions is important – they control to a significant degree both the NMMA groundwater budget as to the quantity of recharge from overlying sources and any calculation of changes in groundwater storage. Further review is needed of well screen intervals, lithology, groundwater level, and other relevant information to segregate wells into the different aquifers groups (e.g. shallow versus deep aquifers) for preparation of groundwater elevation contour maps for different aquifers. In addition, the NMMA will be requesting geologic information obtained during the PG&E long-term seismic studies program.

- **Modifications of Water Shortage Conditions Criteria** – The Water Shortage Conditions and Response Plan was submitted to the Court in 2008. The TG will review the plan on a regular basis.

- **Groundwater Modeling** – The TG continues to recommend the advancement of a groundwater model as presented in the NMMA 5-year Cost Analysis. This may include collaboration with the Northern Cities Management Area, the Santa Maria Valley Management Area or both.

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Appendices

Nipomo Mesa Groundwater Resource Capacity Study, San Luis Obispo County, California

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San Luis Obispo County

Prepared By:

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Table of Contents

Executive Summary

The Department of Water Resources (DWR) analyses, water budget estimates, and projections indicate that groundwater pumping in the Nipomo Mesa area is in excess of the dependable yield. Since current and projected pumping beneath Nipomo Mesa exceeds inflow (natural recharge plus subsurface inflow), the Nipomo Mesa portion of the Santa Maria Groundwater Basin is currently in overdraft and projections of future demand indicate increasing overdraft. Some studies conducted for Nipomo Area Environmental Impact Reports have overestimated the sustainable yield of groundwater and underestimated future groundwater declines and potential for seawater intrusion.

DWR defines overdraft *as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which water supply conditions approximate average conditions."* The statement in the DWR report that the groundwater basin within San Luis Obispo County is currently not in overdraft because of *"consistent subsurface outflow to ocean and no evidence of sea water intrusion"* is inconsistent with DWR's definition of overdraft.

DWR's findings for groundwater beneath the Nipomo Mesa Area are consistent with the County's Resource Management System Water Supply Criterion, Level of Severity III-- existing demand equals or exceeds the dependable supply.

Although existing and projected future water demand at Nipomo Mesa exceeds sustainable groundwater supply based on local water balance analyses, associated potential impact such as seawater intrusion of the aquifer system is not an imminent threat. Hydraulic analyses indicate that a time lag of many decades is likely before heavy groundwater pumping a few miles from the coast results in evidence of seawater intrusion near the coastline.

Declines of 40 to 60 feet in groundwater levels in Santa Maria River Valley occurred between the mid 1940s and late 1960s. Although increased pumping with agricultural development contributed to the drop in groundwater levels, the most important factor appears to be a decrease in recharge due to a prolonged period from 1945 to 1970 with less than average rainfall.

Analysis of historical rainfall data indicate a 30% likelihood that another 10-year period will occur within the next 100 years with annual rainfall nearly 2 inches below average. This would result in major declines in groundwater levels in the Santa Maria River Valley and Nipomo Mesa accompanied by reduced production capability from many wells, increased energy costs for pumping, and increased risk of seawater intrusion of the aquifers near the coastal margin.

Management response to these findings could include increased use of recycled water, increased importation of supplemental water, implementation of additional conservation measures, and appropriate limits on development.

Section 1
Introduction and Background

Increase in population and development of the Nipomo Mesa area of southern San Luis County (Figures 1 and 2) has led to concern by the County about limitations of groundwater supply on which the area is dependent. A 1979 study by the State of California Department of Water Resources (DWR) entitled *Ground Water in the Arroyo Grande Area*, reported that groundwater levels were declining in all parts of the study area as a consequence of groundwater pumping. In 1993, the DWR began a renewed and expanded study of water resources of the area. The results of the DWR study are presented in a 2002 report entitled *Water Resources of the Arroyo Grande – Nipomo Mesa Area*, which is referred to herein as the 2002 DWR Report.

Work by DWR presented in 2002 report was conducted over a period of several years, and during this time several water resource evaluations were also conducted by consulting firms, some on behalf of developers and some for environmental impact reports (EIRs). The DWR report is a voluminous document and valuable compilation of data, however the basis for some of the conclusions and implications regarding sustainable groundwater pumping beneath Nipomo Mesa remain unclear. Moreover, fundamental differences exist between some of the interpretations and conclusions presented in the 1979 and 2002 DWR reports and water resource assessments by consultants.

1.1 Objective and Scope

In June 2003, the County retained S.S. Papadopulos & Associates, Inc. (SSP&A) to conduct a resource capacity study of the Nipomo Mesa area. The objective of the study and this report is to distill relevant information from the DWR report and other water resource assessments of the Nipomo Mesa and vicinity, present an assessment of groundwater resources of the Nipomo Mesa, make recommendations for managing the groundwater resources including appropriate level of severity of depletion of the groundwater resource as part of the County's Resource Management System. In addition to the 2002 DWR Report, SSP&A reviewed numerous documents that pertain to water resources of the Nipomo Mesa and vicinity. A list of references is provided at the end of this report.

1.2 Acknowledgements

John Hand, Senior Planner was the primary contact for the County. John was helpful throughout the project and his comments on preliminary drafts improved this report. Cynthia Koontz, Christine Ferrara, and Frank Honeycutt with the County Public Works Department provided data and contact information. Cynthia Koontz also wrote a useful summary review of the DWR report.

Lew Rosenberg and Martin Feeney shared ideas on hydrogeology of the area. Tim Cleath and Spencer Harris shared data and provided electronic copies of some of their model figures. Dennis Gibbs and Rob Almy at the Santa Barbara County Water Agency, Meryll Gonzalez, Gerhardt Hubner, and Harvey Packard at the RWQCB, and Jodi Isaacs with the Dunes Center helped by sharing information and providing contacts. Don Eley who is the geological coordinator at Unocal Guadalupe Oil Field and Kristine Schroeder with LFR Levine-Fricke provided copies of reports and data on remediation of the Guadalupe Oil Field.

Section 2
Santa Maria Groundwater Basin and Vicinity

2.1 Geology

Nipomo Mesa overlies the northwestern portion of and is contiguous with the Santa Maria Groundwater Basin (Figures 1). The Santa Maria Groundwater Basin is the upper, relatively recent and water-bearing portion of the Santa Maria Geologic Depositional Basin, which includes older Tertiary age consolidated rocks. The aquifer system in the basin consists of unconsolidated Plio-Pleistocene alluvial deposits including gravel, sand, silt and clay with total thickness ranging from 200 to nearly 3,000 feet. The underlying consolidated rocks typically yield relatively insignificant quantities of water to wells. Jurassic and Cretaceous age basement complex rocks of the Franciscan and Knoxville Formations unconformably underlie the Tertiary and Quaternary rocks.

The unconsolidated alluvial deposits in the Santa Maria Groundwater Basin comprising the aquifer system include the Careaga Sand, the Paso Robles Formation, the Orcutt Formation, Quaternary Alluvium, and river channel deposits, sediment, terrace deposits and wind-blown dune sands at or near the surface. Figure 3 depicts conceptual geologic cross-sections and stratigraphy of the primary aquifer system of the Santa Maria Groundwater Basin (Morro Group, 1990). Offsets of the basement rocks and aquifer units by faults, which are not represented in these simplistic cross-sections (Figure 3), are represented on geologic cross-sections prepared by DWR (2002). The DWR 2002 report discusses significant differences in water levels on opposite sides of the estimated trace of the Santa Maria River Fault, suggesting that the fault is to some degree a hydraulic barrier along the eastern margin of Nipomo Mesa. The DWR cross-sections are included in Appendix A, which provides a more detailed discussion of the geology of the Santa Maria Geologic basin.

2.2 Aquifer Characteristics

This summary of aquifer characteristics of the Santa Maria Groundwater Basin is based on a review of several sources of information including the DWR 2002 report, a report on a groundwater flow model and assessment of Santa Maria River Valley groundwater yield (Luhdorff & Scalmanini, 2000), a number of reports regarding development of the

Nipomo Mesa Areas (e.g. Cleath and Associates, 1996a, 1998; ESA 1998). Many of these references rely heavily on estimates of aquifer properties reported by Worts (1951). Estimates of hydraulic conductivity are based on specific capacity values from driller's pumping tests, and aquifer testing conducted on a few wells.

The Santa Maria Groundwater Basin includes the Careaga Sand, Paso Robles Formation, Orcutt Formation, terrace deposits, Quaternary Alluvium, river channel deposits, and dune sand. The Aquifers are generally confined in the western portion of the basin. Focus is on the Paso Robles Formation and Quaternary Alluvium, which are the most important aquifers in the Santa Maria River Valley and Nipomo Mesa areas.

The Paso Robles Formation is the thickest and most extensive aquifer in the basin. The report by Luhdorff and Scalmanini (2000) includes a map with hydraulic conductivity (K) values for the Paso Robles Formation at 20 locations. In the Sisquoc plain, Orcutt Upland, and central Santa Maria River Valley, K ranges from 100 to 400 gpd/ft^2 (13 to 52 ft/d). Values are lower in the western portion of the Santa Maria River Valley and beneath Nipomo Mesa where the reported values range from 15 to 110 gpd/ft^2 (2 to 15 ft/d). The wells are typically screened over hundreds of feet of the Paso Robles Fm, so these values represent bulk averages for the formation.

The Quaternary Alluvium is the most permeable aquifer, although few testing data seem to be available to estimate hydraulic conductivity. Luhdorff & Scalmanini show seven locations with estimates of hydraulic conductivities. As for the Paso Robles Formation, data indicate that the hydraulic conductivity of the Alluvium generally decreases to the west. Values of 4500 gpd/ft2 (600 ft/d) are typical in the Sisquoc plain, while 2000 gpd/ft2 (265 ft/d) is typical for the lower portion of the alluvium near Guadalupe. Typical thickness for the Quaternary Alluvium in the Santa Maria River Valley is 100 to 200 feet. Near Guadalupe the upper portion of the alluvium is generally fine-grained and acts as a hydraulic confining layer above the lower alluvium and Paso Robles Fm.

Luhdorff & Scalmanini (2000) report specific yield values in the range of 8 to 13 percent, and assume a reasonable value of storativity of 0.0001 for portions of the aquifers system under confined conditions.

2.3 Historical Precipitation Record

DWR compiled and analyzed long-term precipitation records from 36 stations in San Luis Obispo and Santa Barbara Counties (DWR, 2002) and constructed a map showing contours of equal mean annual precipitation based on records from 1870 to 1995. The DWR rainfall map is included as Figure 4. The long-term average annual rainfall in the northern portion of the Santa Maria Groundwater Basin is approximately 14 inches. The majority of rainfall occurs between November and April. Figure 5 shows historical rainfall records for Santa Maria, Nipomo Mesa, and San Luis Obispo.

Cumulative departure curves are useful for evaluating long-term rainfall trends. Figure 6 shows graphs prepared by DWR of cumulative departure from mean precipitation for three stations: (1) California Polytechnic University, San Luis Obispo, (2) Nipomo, and (3) Santa Maria. As indicated on the graphs, long-term downward sloping trends correspond to prolonged periods of less than average rainfall, and upward sloping trends correspond to prolonged periods of more than average rainfall. Based on the cumulative departure curve for San Luis Obispo rainfall, the DWR report identified three wet-dry cycles of precipitation: 1884-1900, 1901-1934, and 1935-1966. In addition, a fourth wet-dry cycle appears to have begun in 1967. Similar cycles are evident on cumulative departure curves for Nipomo and Santa Maria.

Based on the long-term rainfall data, DWR chose 1984-1995 as the base hydrologic period, which is intended to be representative of long-term conditions and encompass dry, wet, and average years of rainfall. This twelve-year period included the most recent pair of dry and wet trends and begins and ends with a series of wet years. In addition, data are available for the 1984-1995, and the period reflects recent conditions.

2.4 Watersheds and surface water

Most of the Santa Maria Groundwater Basin is within the Santa Maria River Watershed, which extends eastward into the coastal range region and covers nearly 1.2 million acres. The California Rivers Assessment (CARA) program[1] divides the Santa Maria River Watershed into two sub-basins: the Cuyama Basin, which is the upper portion of the watershed, and the Santa Maria, which is the lower portion of the watershed. Figure 7 provides maps showing the extent of each.

The Santa Maria portion of the watershed, which includes the Sisquoc and Santa Maria Rivers, covers an area of 453,777 acres (1,836 sq km) and the average annual precipitation (weighted by area) is 19.7 inches. The Cuyama portion of the watershed covers an area of 732,147 acres (2,963 sq km) and average precipitation is 16.3 inches per year. Average precipitation for these watersheds is greater than that for the northwestern portion of the Santa Maria Groundwater Basin because the watershed boundaries extend further inland and include highlands, which receive the most precipitation.

The Santa Maria River begins at the confluence of the Cuyama and Sisquoc Rivers near the town of Garey and it forms the border between Santa Barbara and San Luis Obispo Counties. The Santa Maria River Valley is the major surface water drainage of the Santa Maria River Watershed and a major source of recharge to the aquifers beneath the valley. The Santa Maria River Channel meanders westward some 20 miles over extensive

[1] The California Rivers Assessment (CARA) program is a computer-based data management system designed to give resource managers, policy-makers, landowners, scientists and interested citizens rapid access to essential information and tools with which to make sound decisions about the conservation and use of California's rivers. The website (http://endeavor.des.ucdavis.edu/newcara/) and program is managed by the Information Center for the Environment at UC Davis.

permeable alluvial deposits with high infiltration potential on its way to the Pacific Ocean. Flow of water in the Santa Maria River Channel is intermittent, occurring only during periods of high seasonal runoff.

The flows of the Sisquoc River and its tributary creeks have been unimpaired throughout the historical period of record, and stream gauging data for the Sisquoc River near Garey are available since 1942. The Cuyama River, which drains a portion of the Sierra Madre Mountains, has been controlled since 1959 by Twitchell Dam (Figure 1).

The Bureau of Reclamation (BOR) constructed Twitchell Dam during the period from July 1956 to October 1958. BOR reports a total storage capacity behind the dam of 224,300 acre-feet (http://www.usbr.gov/dataweb/html/santamaria.html). The Dam is on the Cuyama River about 6 miles upstream from its junction with the Sisquoc River.

After construction, BOR transferred operations to the Santa Barbara County Water Agency. Currently, the Santa Maria River Valley Water Conservation District physically operates the reservoir. Floodwaters of the Cuyama River stored behind the dam are released from the dam as quickly as they can be percolated into the Santa Maria River Valley ground-water basin. An important objective of the operation of the dam is to attempt to prevent salt-water intrusion into the aquifers of the Santa Maria River Valley by helping to increase recharge to groundwater and to maintain outflow to the ocean (http://www.usbr.gov/dataweb/html/santamaria.html).

When the Sisquoc and Santa Maria Rivers are no longer flowing from natural run-off, available water from Twitchell Reservoir is slowly released and allowed to seep into the ground as it flows towards the ocean. Because water is released from the dam nearly continuously, Twitchell Reservoir is empty much of the time. The discharge rate is controlled, typically at 12,500 cubic feet per second (cfs). At this flow rate water rarely flows past Bonita School Road crossing, nearly 20 miles from the dam and 3.3 miles east of Guadalupe. Even prior to construction of the dam, water flowed in the river all the way to the mouth at the Pacific Ocean only during extended periods of high runoff.

Water nearly always flows in the last few miles of the Santa Maria River bed downstream of Guadalupe. USGS topographic maps (Guadalupe, Point Sal 1:24,000, and Santa Maria 1:100,000 quadrangles) depict a dry Santa Maria River bed in the vicinity of Guadalupe, but flowing water in the last 4 miles of the river, beginning 1.5 miles downstream of Guadalupe. This is likely a consequence of groundwater discharge to the river near the sea. This portion of the Santa Maria River is a gaining river—it functions as a drain for groundwater in the shallow aquifers in this region. The hydraulic gradient is upward from the deeper confined aquifers to the shallow aquifers so upward leakage of groundwater contributes to the shallow aquifers in this area. Irrigation return flows also contribute water to the river. In addition, small but essentially year-round flow from Orcutt Solomon Creek joins the Santa Maria River at the confluence approximately 1.2 miles upstream from the sea (phone conversation with Dunes Program Manager, http://www.dunescollaborative.org/index.html).

2.5 Santa Maria River Valley

Gauging data for the Santa Maria River near Guadalupe are available since 1941. During the period from 1941 to 1959, before the construction of Twitchell Dam, the number of days per year that the Santa Maria River near Guadalupe flowed was generally decreasing from an average of 30 days in 1941 to less than 10 days in 1959. As a consequence of management of Cuyama River flows after construction of Twitchell, the 1960 to 1987 record at Guadalupe shows a stabilized trend with an average of 10 days per year with water flowing in the River. This is a consequence of management of flows with the Twitchell Dam.

Major declines in groundwater levels in Santa Maria River Valley wells and decrease of the groundwater hydraulic gradient toward the ocean occurred between the mid 1940s and late 1960s. Drops in water level of 40 to 60 feet were common in wells during this period (e.g. DWR, 2002; Luhdorff & Scalmanini, 2000). Total dissolved solids (TDS) in groundwater east of Guadalupe was less than 1000 mg/l in the 1930s, but increased to greater than 3000 mg/l by 1975 (Santa Barbara County Water Agency, 1996, 1999). Increasing groundwater pumping and possible surface water diversions to support flourishing agricultural development in Santa Maria River Valley contributed to the drop in groundwater levels, decrease in flows in the Santa Maria River, and increase in TDS in groundwater. However, the most important factor appears to be a decrease in recharge due to a prolonged period from 1945 to 1970 with less than average rainfall. Graphs of cumulative departure from mean precipitation (Figure 6) illustrate this period of low rainfall.

Substantial recovery of groundwater levels in the Santa Maria River Valley occurred in the 1970s and 1980s. Management of Cuyama River floodwater flows by Twitchell Dam began in 1959 and is credited with increasing recharge to the Santa Maria River Valley and helping to arrest the decline in groundwater levels. Reported estimates of supplemental recharge since construction of the dam range from 20,000 acre-feet per year (AF/Y) (Dames and Moore, 1991) to 38,000 AF/Y (Luhdorff & Scalmanini, 2000). However, these estimates of supplemental recharge are much too large relative to the Cuyama River Flows. Supplemental recharge due to control of storm water flows cannot exceed the total average flow below the dam, and is likely a relatively small portion of the total average flow. Available gauging data for Cuyama River below Twitchell Dam indicate average annual flow in the range of 35,000 to 39,500 AF/Y.

Prior to, as well as after construction of Twitchell Dam, most of the water in the Santa Maria river infiltrated the Santa Maria Valley prior to reaching the mouth at the Pacific Ocean. River water flowed all the way to the Ocean only during extended periods of high runoff. Even prior to the construction of the dam, this occurred on average only several days per year. Based on comparison of Santa Maria River flow records before and after construction of the dam, we estimate that management of Cuyama River discharge at

Twitchell dam[2] enhances average recharge to the Santa Maria River Valley aquifers by no more than 10,000 to 15,000 acre-feet per year. As is discussed in Section 3.4.1 below, the data indicate that long-term variation of rainfall has had much more influence groundwater levels in Santa Maria than Twitchell Dam.

Luhdorff & Scalmanini (2000) report that hydrographs records for the period from the early 1980s to late 1990s show successive periods of decline and recovery that are not consistent with perennial overdraft[3]. Reported estimates of the annual yield of the basin include 120,000 AF (SB Co, 1996, 2000, 2002; Ahlroth, 1995), and 124,000 during the period 1968-1989, which Luhdorff & Scalmanini (2000) report as the approximate sustainable perennial yield[4]. Based on estimates by Luhdorff & Scalmanini (Figures 4-10, 4-12, Luhdorff & Scalmanini, 2000), average demand (groundwater pumping) in the Santa Maria River Valley was 96,200 AF/Y during the period from 1945 to 1970, and 140,000 AF/Y in 2000.

Water balance evaluations for Santa Maria Groundwater Basin using hydrologic conditions based on 45-year period from 1935 to 1979 are reported to indicate average annual deficits of 6,000 AF for historical water demand conditions, and 20,000 AF for water demands projected into the future from the late 1990s (Santa Barbara County, 1992, 1994, 1996, 2000, 2002). However, this estimated deficit is reduced by importation of water to Santa Barbara County beginning in 1996 from the State Water Project (SWP). Santa Barbara County estimated that 12,000 AF of SWP water were imported to the Santa Maria Groundwater Basin in 1999. This reduces the estimated deficit from 20,000 to 8,000 AF/Y. And if we assume that recharge enhancement by Twitchell Dam of 10,000 AF/Y

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[2] During the period from 1959 to 1983 reported average annual flow in the Cuyama River below Twitchell Dam flow of the Cuyama River is 35,372 AF/Y (pgs E5-E6, DWR, 2002). Our calculation of average flow based on monthly USGS gauge data for a similar time period is 54.4 cfs or 39,456 AF/Y.

[3] *Groundwater Overdraft* is defined in the glossaries to the California Water Plan Update and California's Groundwater Bulletin 118 – 2003 Update (DWR 1998; DWR 2003) as "the condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions." However, the DWR Nipomo Mesa Report and in the text of the Bulletin 118 – 2003 Update (DWR, 2002; pg 154, DWR 2003), also define groundwater overdraft as a condition of a groundwater *subbasin*. *Perennial Overdraft* is sustained overdraft over a long period of time.

[4] *Perennial Yield* is defined in the glossary to the California Water Plan Update (DWR, 1998) as the "maximum quantity of water that can be annually withdrawn from a groundwater basin over a long period of time (during which water supply conditions approximate average conditions) without developing an overdraft condition." We consider *sustainable yield*, *sustainable perennial yield*, *perennial yield*, and *dependable yield* to be equivalent terms. In the glossary to the 2002 Nipomo Mesa report, DWR defines *dependable yield* as the "average quantity of water that can be extracted from an aquifer or groundwater basin over a period of time (during which water supply conditions approximate average conditions) without resulting in adverse effects such as subsidence, sea water intrusion, permanently lowered groundwater levels, or degradation of quality. If water management in the basin changes, the perennial yield of the basin may change." *Safe yield* also directly implies consideration of negative consequences and is defined in the 2003 update to Bulletin 118 (pg 99, DWR, 2003) as "the amount of groundwater that can be continuously withdrawn from a basin without adverse impact." Some papers that address a common misconception that safe yield is equivalent to the rate of natural recharge are provided in Appendix B.

directly contributes to yield, then the estimated deficit is erased and instead there is a surplus of 2,000 AF/Y. Table 1 summarizes estimates of yield and demand for year 2000 in Santa Maria Valley.

Clearly, these estimates of a yield, demand, and supplemental yield due to enhanced recharge are not precise numbers. Their accuracies are influenced by many uncertain assumptions. Moreover, the recharge enhancement provided by management of flood water discharge from Twitchell Dam may diminish in the future due to depletion of Cuyama river flows by groundwater pumping in Cuyama Valley (DWR, 2003) and decrease in storage capacity with accumulation of sediment in Twitchell Reservoir (e.g. SAIC et al., 2003). Without the assumed 10,000 AF/Y of enhanced recharge, the estimated projected deficit was 8,000 AF/Y, which is only 6.5% of Lurdorff & Scalmanini's estimate of sustainable perennial yield. In other words, the water balance deficit may be a small fraction of the sustainable yield for *average* rainfall conditions.

Table 1
Reported Estimates of Annual Groundwater Yield, Demand, and Deficit in Year 2000
Santa Maria River Valley

Perennial Yield (AF/Y)	Recharge Enhancment (AF/Y)	SWP Supplement (AF/Y)	Demand in Year 2000 (AF/Y)	Deficit in Year 2000 (AF/Y)
120,000	10,000	12,000	140,000	-2,000 (surplus)

2.5.1 Prolonged Period of Low Rainfall Results in Overdraft

Regardless of details about basin yield and deficits, the data show that a major decline of groundwater levels (drops of 40 to 60 feet) occurred as a consequence of reduced recharge from the river to the Santa Maria River Valley due to a prolonged period from 1945 to 1970 with less than average precipitation. The average annual rainfall during this 25-year period was 2.11 inches (16%) less than the average (13.60 inches) over the entire historical record (1886-2003). Many hydrographs from wells in the Santa Maria River Valley show that major decline in water levels occurred in the first five or ten years during this 25-year period. Based on the 177-year precipitation record for Santa Maria, we have evaluated the probability of prolonged periods with less than average rainfall in the future, which would again result in major decline of groundwater levels in Santa Maria River Valley.

We calculated sliding window averages (moving average) from Santa Maria precipitation record for a 10-year window. Statistical evaluation of this data set provides a basis for estimating probability of future conditions that would result in a major decline in groundwater levels in Santa Maria River Valley, such as occurred during the period from the 1940s to late 1960s. Figure 8 provides graphic illustration of the data and the statistical summary for 10-year moving average data set. The data indicate that the chance is approximately 30% in the next 100 years that a 10-year period will occur with average annual rainfall nearly 2 inches below average, which would result in a major decline in groundwater in the Santa Maria River Valley.

Moreover, this analysis likely underestimates chances of conditions in the future that would result in a major decline of groundwater levels in the Santa Maria River Valley because current and future water demand is greater than average demand during the historical overdraft period upon which this analysis is based. In addition, future contributions to Santa Maria Groundwater Basin from the Cuyama River may decrease as increasing demands deplete water resources in Cuyama Valley, which has been reported to be in a condition of critical groundwater overdraft[5] (e.g. pg 98, DWR, 2003, and Cuyama Valley Study[6]).

For the period from 1895 to 1947, the average annual natural runoff in the Santa Maria River system was estimated at 90,900 AF (pg 49 and Appendix E, DWR, 2002)[7]. Gauging data for the Santa Maria River near Guadalupe recorded since 1941 indicate a much lower average annual flow of 21,700 AF. Moreover, for the period from 1941 to 1987, the majority of time, flow is zero at Guadalupe. Flow exceeding 1 cubic foot per second (cfs) at Guadalupe only occurs an average of 21 days each year (Figure 9). DWR attributes the decrease in average flow in the Santa Maria River to impoundment of runoff at Twitchell Reservoir and presumably increased recharge with controlled releases.

The record from 1941 to 1959, which is before the construction of Twitchell Dam, the number of days per year that the Santa Maria River near Guadalupe flowed was generally decreasing. A trend line fitted to the data drops from an average of 30 days in 1941 to less than 10 days in 1959. Increasing groundwater pumping near the river due to agricultural development in Santa Maria River Valley likely contributed to this trend. The post-Twitchell Dam record, 1960 to 1987, shows a stabilized trend with an average of 10 days per year with water flowing in the River (Figure 9). This is a consequence of management of flows with the Twitchell Dam. Average annual flow data for this gauging station show the same trends (http://water.usgs.gov/cgi-bin/wuhuc?huc=18060008).

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[5] Definition of *Critical Overdraft* (pg 98, DWR, 2003): "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."
[6] Cuyama Valley Irrigation Water Management & Groundwater Study conducted by researchers at the UC Davis Information Center for the Environment for the USDA - Natural Resources Conservation Service in cooperation with the Cachuma Resource Conservation District: http://endeavor.des.ucdavis.edu/nrpi/NRPIDescription.asp?ProjectPK=4988
[7] Original data source: California State Water Resources Board, Bulletin 1, 1951.

The amount of additional recharge provided to the Santa Maria River Valley by management of Cuyama River flows by Twitchell Dam appears to have been overestimated. In addition, both overdraft in Cuyama Basin (e.g. pg 98, DWR, 2003) and decrease in the capacity of Twitchell reservoir caused by accumulation of sediment (SAIC et al., 2003) will reduce the additional recharge to Santa Maria River Valley in the future. Importation of State Water to Santa Maria River Valley has helped avoid overdraft conditions, however, the data indicate that a series of several years with less than average rainfall would lead to significant decline in groundwater levels in the Santa Maria River Valley and accompanying reduced production capability from many wells, increased energy costs for pumping, and increased risk of seawater intrusion of the aquifers near the coastal margin.

2.6 Groundwater Quality

Total dissolved solids (TDS) in groundwater generally increase from east to west. TDS east of Guadalupe <1000 mg/l in the 1930s, but increased to >3000 mg/l by 1975. In the vicinity of Santa Maria and Guadalupe, the basin is classified as vulnerable to nitrate contamination, and in places, concentrations of nitrate have increased from <30 mg/l in 1950s to over 100 mg/l in the 1990s (Santa Barbara County, 1996, 1999). The Careaga Sand, which is the basal member of the system of alluvial aquifers in the basin, is generally considered to have poor water quality (e.g. Dames and Moore, 1991).

2.7 Groundwater Levels and Flow Directions

The California Department of Water Resources began monitoring groundwater levels in some wells in the Santa Maria Groundwater Basin in the 1930s. Most of the available water level data are from pumping wells and usually it is not known if the wells are pumping or idle, or how long pumping was curtailed before making a water level measurement. As a consequence the water level data are of limited value. However, particularly for wells with long records, the general trends can be useful and informative.

Profiles along the Santa Maria River of historical groundwater levels show that major decline of groundwater levels occurred as a result of expansion of irrigated agriculture in the 1920s and 1930s. Prior to the beginning of heavy pumping for irrigation, confined hydraulic groundwater head elevations were 50 to 75 feet higher within a few miles of the coast (e.g. Morro Group, 1996). Over the years, the transition between unconfined and confined conditions has generally migrated westward toward the coast. This means that water levels have dropped below confining intervals (aquitards) so the water is no longer under confined (pressure) conditions. Prior to the decline in water levels, groundwater discharged to the Santa Maria River near the coast, but as hydraulic head in the aquifer dropped contribution near the coast of groundwater to baseflow of the Santa Maria River decreased and the potential for seawater intrusion of the aquifers increased.

General groundwater flow in Santa Maria basin is east to west, from the Sisquoc area toward the ocean. As a consequence of agricultural demands on groundwater in the Santa Maria River Valley, the hydraulic gradient flattened considerably beneath the central and western portions of the basin between the mid-1940s and mid-1960s. Luhdorff & Scalmanini report that since the mid-1960s the flattening of the hydraulic gradient in the SMV has fluctuated and the portion of the Santa Maria Valley along the upper reach of Santa Maria river shows influence of increased recharge due to management of flows by Twitchell Dam.

Section 3
Nipomo Mesa

3.1 Geology and Hydrogeology

A mantle of late Pleistocene eolian (wind-blown) dune sands underlies the elevated area, known as Nipomo Mesa. The dune deposits were once much more extensive, but most were eroded away during the last ice age by the ancestral Arroyo Grande Creek, Los Berros Creek, and Santa Maria River. Today the Nipomo Mesa older dune sands is a triangular lobe more than 4 miles wide on the coastal side and extending inland more than 12 miles just east of Hwy 101. Lithologic logs of water wells indicate that the Nipomo Mesa dune sands are 150 to 250 feet thick. The Nipomo Mesa dune sands are very porous and permeable, and very little runoff leaves the Mesa. DWR (2002) reports that little runoff occurs from the bluffs at the margins of Nipomo Mesa, but that increased development has resulted in some increase in runoff from the mesa to the adjacent Arroyo Grande Plain and Santa Maria River Valley.

Groundwater in the dune sands is of relatively minor significance for water supply and the primary aquifer is the underlying Paso Robles Formation where groundwater is in hydraulic continuity with the Santa Maria groundwater basin (e.g. Morro Group, 1996; Cleath and Associates, 1996a, 1998; ESA 1998; DWR, 2000). Hydraulic conductivity of Paso Robles Formation is generally lower beneath Nipomo Mesa and in the western portion of the Santa Maria River Valley relative to the eastern portion; reported values range from 15 to 110 gpd/ft2 (2 to 15 ft/d) (e.g. Luhdorff & Scalmanini, 2002, Morro Group, 1996, Cleath and Associates 1996a).

The dune sands locally contain clay layers on which groundwater is perched. In addition, fine-grained layers in the upper portion of the Paso Robles Formation beneath dune sands are reported to function as a perching layer (Morro Group, 1996). Some of the shallow groundwater that percolates downward within the permeable Nipomo Mesa dune sands is diverted laterally along these low-permeablity layers and discharges into Black Lake Canyon and supports Black Lake and the other systems of coastal drainages and lakes west of Nipomo Mesa including the creek in Cienega Valley, Celery Lakes, White Lake, Little Oso Flaco Lake and the creek along the southwest margin of Nipomo Mesa.

The majority of water demands in the Nipomo Mesa area are supplied with groundwater because there are no significant creeks or rivers. As a consequence DWR (2002) reports that the main source of recharge is percolation of rainfall. However, subsurface inflow from Santa Maria River Valley is also an important component of the groundwater balance of the Nipomo Mesa area.

The amount of recharge to groundwater from precipitation on the Mesa is controversial, and estimates vary wildly—from zero to 100 percent. Cleath and Associates (1996a) estimated that 25% of rainfall on Nipomo Mesa percolates to groundwater, which equates to 5625 AF/Y of recharge over an area of 18,000 acres. However, Cleath and Associates (1997) subsequently advocated that extensive groves of eucalyptus trees intercept essentially all rainfall and prevent any recharge to groundwater for portions of Nipomo Mesa. Removal of gum trees and engineering of suburban runoff should locally increase recharge, but may not make significant difference to recharge to main aquifers on scale of the Nipomo Mesa.

3.2 Groundwater Levels and Flow Directions

Interpretation of groundwater flow directions from groundwater contour maps for the Nipomo Mesa is difficult because in some cases data is included from wells, which are screened within perched groundwater in the dunes, and little information regarding pumping status for wells is available. In addition, groundwater levels are discontinuous across the Santa Maria River Fault, which functions as a partial hydraulic barrier along the northeast margin of the Nipomo Mesa (e.g. Luhdorff & Scalmanini, 2000). In the early 1970s, some groundwater contour maps depicted a general groundwater mound beneath Nipomo Mesa with flow to the south to Santa Maria River Valley, to the northwest toward Arroyo Grande Valley, and to the west toward the sea. In general, however, most groundwater contour maps show westward flow toward the sea.

DWR (2002) presented contour maps of groundwater levels for Spring 1975, 1985, 1995 and 2000, included herein as Figures 10 to 13. These contour maps show that marked depressions associated with heavy pumping beneath parts of Nipomo Mesa have a significant influence on local groundwater flow directions. Based on our review of available water level from specific wells, the 1995 DWR contour map (Figure 12) appears to underestimate the depth and extent of a significant groundwater depression beneath Nipomo Mesa. Static water levels recorded in four wells installed in 1993 and 1994 for the Woodlands project over an area of approximately 4 square miles, are 6 to 31 feet lower (average 14 feet lower) than water levels indicated by the DWR water level contour map for 1995. These water level data are posted on Figure 12.

The County measures water levels twice a year in approximately 85 wells in the San Luis Obispo County portion of the Santa Maria Basin and recently completed compiling historical data and upgrading the database of groundwater elevations. Hydrographs, which depict water level elevation versus time, are provided in Appendix C for 20 wells in the

Nipomo Mesa Area. A line fitted to the entire data record is included on each hydrograph to show general trend in water level over the entire period of record. An overall decreasing trend in water level prevails.

Most wells on Nipomo Mesa with water level elevations greater than 100 feet are likely completed within or across intervals of shallow perched groundwater in the dune deposits. Such wells are not representative of the regional water level in the underlying Paso Robles Formation, which is the primary aquifer.

Based on the County water level database, several of the Nipomo Mesa wells have water levels below 10 feet MSL and a few have water levels below sea level even for non-pumping conditions. Note also, that in most cases the water levels are recorded for non-pumping conditions, and the pumping levels are generally several tens of feet lower.

3.3 Groundwater Budget and Change in Storage

DWR (2002) evaluated groundwater deficits and surpluses beneath the Nipomo Mesa for the period from 1975 to 1995 using both the specific yield-change in water level method and estimates of difference between inflow and outflow (water budget). Cumulative loss of groundwater storage over the twenty years is 7,000 AF using the change in water level method, and 11,000 AF using the water budget method. For a similar time period, 1976 to 1992, Cleath and Associates (1996a) estimated that volume of Nipomo Mesa groundwater in storage above sea level decreased from 55,200 to 49,200 AF, a net deficit of 6,000 AF, which is similar to the estimated deficits reported by DWR. Note however, that the Addendum to the DWR 2002 report includes an update using data for 2000, and as a consequence of rise in water levels between 1995 and 2000, the DWR analysis indicates zero net change in groundwater storage beneath Nipomo Mesa for the 25-year period from 1975 to 2000.

Based on the data and calculations for the period from 1975 to 1995, DWR (2002) estimated that dependable groundwater yield beneath Nipomo Mesa is in the range of 4,800 to 5,000 AF/Y. DWR also reported that projected groundwater demand for the Nipomo Mesa area exceeds the estimated dependable yield by approximately 50% in 2010, and 80% in 2020. As consequence of an expected decline in water levels, the hydraulic gradient would increase toward Nipomo Mesa from Santa Maria River Valley and the rate of groundwater influx would increase. However, DWR cautioned that increased groundwater flow from Santa Maria River Valley "might not be a desirable long-term solution to meet the water supply needs of the Nipomo Mesa."

Water budget estimates reported by DWR (Table 26, 2002) indicate that subsurface influx of groundwater to Nipomo Mesa from the Santa Maria River Valley accounts for about 35% of the total inflow of water for Nipomo Mesa (including rainfall). Groundwater modeling by Cleath and Associates (1996a) of increased pumping associated with Nipomo Mesa development projects indicates that approximately half of the increased groundwater extraction at Nipomo Mesa comes from Santa Maria River Valley and ultimately recharge from the Santa Maria River. A more detailed discussion and analysis of the water budget estimated by DWR for Nipomo Mesa follows.

3.4 Estimates of Groundwater Demand and Capacity

DWR (2002) reported annual estimates of water budget for Nipomo Mesa for the period from 1975 to 1995, and for future years 2010 and 2020. Estimated components of inflow include

- deep percolation of precipitation;
- urban return;
- agricultural return;
- other return (zero for Nipomo Mesa);
- recharge of recycled water;
- subsurface inflow from Santa Maria River Valley and Nipomo Valley.

Estimated components of outflow include

- urban, agricultural, and other groundwater extraction;
- subsurface outflow to Tri-Cities Mesa – Arroyo Grande Plain; and
- subsurface outflow to the Ocean

Chapter 7 in the DWR report includes a discussion of each of these water budget components, and DWR Table 26 lists the annual values for each component for the period from 1975 to 1995, as well as for 2010, and 2020. Figure 14 illustrates the average contribution of each of the inflow and outflow components for DWR's Nipomo Mesa water budget estimates. DWR selected water years 1984 to 1995 as the base period for their evaluation. This period encompassed the most recent pair of wet and dry trends.

Figure 15-A shows DWR's estimated annual values for total inflow and outflow for Nipomo Mesa for the 20-year period from 1975 to 1995 and projected estimates for years 2010 and 2020. Average annual inflow during the study base period (1984-1995) is also shown on the graph (Figure 15-A). This graph shows that DWR's estimates of total outflow have exceeded average inflow since 1980 with an apparent increase in deficit with time.

Figure 15-B is a graph showing more detail of the DWR (2002) water budget annual estimates (see also Figure 14). The annual value of deep percolation component of inflow varies greatly because it is a function of rainfall. Components of inflow other than deep percolation (60 percent of which is groundwater inflow from Santa Maria River Valley) are more stable and show two nearly flat trends during the 20-year period of analysis: (1) 1975 to 1985 and (2) 1986 to 1995. We have fitted a line through these data and the DWR estimates for 2010 and 2020. This suggests a 1000 AF per decade increase (12.5 percent) in inflow to groundwater beneath Nipomo Mesa other than deep percolation of rainfall and accounts for increase subsurface inflow in response to increasing hydraulic gradient toward Nipomo Mesa with increases in pumping.

Figure 15-B also shows a trend line fitted to the 20-year period of outflow values to provide an estimate of outflow rates in the future. The trend increases at a rate of 1.2% per year. DWR's estimated values of outflow for years 2010 and 2020 are close to this projected trend. Also shown on Figure 15-B (open diamond symbols) are estimates of Nipomo Mesa water demand for years 2002 and 2020 from the County Master Water Plan Update (January, 2003) discussed in Section 3.5 below. These two demand estimates by the County (9.2 AF/yr in 2002 and 12.6 AF/yr in 2020) equate to an increase of 1.75% per year. The filled diamond symbols at 2002 and 2020 are the County's Nipomo Mesa Demand estimates with the DWR estimates of subsurface outflow added (Table 26, DWR, 2002).

We used trends and averages of the DWR water budget components to project two ranges of estimated inflow to Nipomo Mesa. These and the projected outflow are shown on Figure 15-C. One inflow range is constant with time. The lower value (6,800 AF/yr) is based on the DWR average inflow estimate for their base period: 1984-1995 (Table 26, DWR, 2002). The upper value (7,800 AF/yr) is based on average deep percolation for the 20-year period from 1975-1995, which is greater than the DWR base period (1984-1995), and average inflow (excluding deep percolation of rainfall), during the period from 1986 to 1995 (Table 26, DWR, 2002), which is the higher other inflow plateau shown on Figure 15-B.

The other inflow range shown on Figure 15-C increases with time. The rate of increase is based on the trend line fitted to the DWR estimates of components of inflow, not including deep percolation, for the period 1975-1995 and including the estimated values for years 2010 and 2020. This trend line and the data are shown on Figure 15-B. Addition of the average value of deep percolation for the DWR base period (1984-1995) gives the bottom of the increasing inflow range. And, addition of the average value of deep percolation for the 20-year period (1975-1995) gives the top of this increasing inflow range.

This analysis of the DWR water budget estimates for Nipomo Mesa shows outflow outpacing inflow even if we account for estimated increasing influx of groundwater from Santa Maria River Valley due to increasing pumping beneath Nipomo Mesa. By year 2025, estimated outflow exceeds the highest of a range of inflow estimates by 20 percent (Figure 15-C)—substantial overdraft and mining of groundwater in storage, and accompanying reduced production capability from many wells, increased energy costs for pumping, reduction of groundwater discharge to the coastal drainages and lakes west of Nipomo Mesa, and increased risk of seawater intrusion of the aquifers near the coastal margin.

3.5 Nipomo Water-Planning Area

The first phase of the San Luis Obispo County's Master Water Plan Update defined twelve Water Planning Areas (WPA) that are based on geography and land use (EDAW and Boyle, 1998). The County addresses water supply and demand separately for each WPA. The Nipomo Area (WPA 6), which is one of six coastal water-planning areas in the County, includes the southern portion of the County. To better address specific water needs, the second phase of the Master Water Plan Update divided WPA 6 into four geographic water-demand sub-regions: Nipomo Mesa, Nipomo Valley, which is east of Hwy 101, the Suey Creek Area, which is further southeast, and the portion of the Santa Maria River Valley in San Luis County (north of the Santa Maria River). Figure 2 illustrates the subareas of WPA6.

Nipomo Community Services District (NCSD) and the Southern California Water Company (SCWC) are the primary municipal water purveyors in WPA 6. In addition there are approximately 25 private water purveyors that pump groundwater beneath WPA 6. In addition, there are hundreds of private domestic wells.

Estimates by the County (January 2003a) of current and projected water demand for the Nipomo Mesa sub region of WP6 (Figure 2) are summarized in the table below. Estimates of urban demand provided by the table only include water provided to customers serviced by NCSD and SCWC. These estimates are based on NCSD and SCWC records and projections.

Table 2
Summary of Estimates by the County of Water Demand for Nipomo Mesa

Category of Demand	Year 2002 (1000 af/yr)	Projected Demand Year 2020 or Build Out (1000 af/yr)
Urban	3.9	7.34
Agricultural	2.9	1.9
Rural	2.42	3.35
Environmental	0	0
Total	9.22	12.59

Considerable effort by the County and consultants went into the estimates of agricultural demand, which is also called Gross Irrigated Water Requirements (GIWRs) in the County Master Water Plan Update document. The estimates incorporate assessment of acreages of various crop types, evapotranspiration, effective rainfall, frost protection, leaching requirements, and irrigation efficiency. In the 2003 Update for WPA 6 (San Luis Obispo County, 2003a), the County reported a range of agricultural demand: 2,400 to 3,580 AF in 2002, and 1,440 to 2,280 AF in 2020. The average of each range is provided in Table 1 above.

Rural water demand includes rural dwelling units, schools, churches, and some commercial and industrial facilities, irrigation water for the Black Lake and Cypress Ridge golf courses, and the proposed Woodlands Development. It includes water provided by purveyors other than NCSD or SCWC as well as private domestic wells.

Because most private wells are not metered, rural water demand was estimated by number of dwelling units (DU) and parcel size. Duty factors were 0.5 AF/DU/YR for homes on less than one acre, 1.5 for homes on more than an acre, and 2 AF/ACRE/YR for golf courses. The County used estimates of 1550 dwelling units in 2002, and 2,300 at build-out.

Environmental demands include conditions on water right permits and licenses and associated orders by the State Water Resources Control Board, California Fish and Game, and other regulatory agencies. No current environmental demands are in place, and the County assumed none for 2020. However, the possibility exists that future environmental demands for Nipomo Mesa could be put in place to help ensure minimum discharges to Black Lake Canyon and the lakes and coastal watersheds west of the mesa.

3.6 Groundwater Modeling to Assess Impact of Development

Despite concern that recent and proposed residential developments of the Nipomo Mesa may accelerate the depletion of groundwater storage and degrade the quality of groundwater near the coast by inducing salt-water intrusion, some hydrogeologic evaluation and groundwater modeling reports (e.g. Cleath and Associates, 1996a, 1997; 1998; ESA 1998) assert that the impact of additional pumping for proposed development is insignificant. However, for several reasons some of the model results may underestimate the future groundwater declines and overestimate sustainable yield:

- Typically, the model runs to estimate potential future impact of a project were conducted by adding increased pumping associated with a proposed development, but the rest of the pumping assigned in the model remained constant for model simulations, 48-years into the future. This does not account for cumulative impact of projected increased future groundwater demand for other portions of Nipomo Mesa and the Santa Maria River Valley and underestimates future water budget deficits.

- No model simulations are presented with long periods with less than average rainfall.

- After the Woodlands model was developed, information became available indicating that Eucalyptus Globulus trees have dense mat of shallow roots that store excess water and use 80-90 % of rainfall. Since the majority of 863 acres of these trees would be removed for the development project, the model runs to estimate potential impact to groundwater were revised to reflect increased recharge of rainfall to groundwater after removal of the eucalyptus trees. However, apparently the base case model was not revised using reduced recharge before removal of the trees. This revision would likely require recalibration and local reduction of hydraulic conductivity resulting in increased groundwater drawdown associated with additional pumping.

- The model may not adequately account for interception and diversion of infiltrating water by low-permeable intervals within both the Nipomo Mesa dunes and upper portion of the Paso Robles Formation. Consequently the model may overestimate recharge to the main aquifer beneath Nipomo Mesa.

Hydraulic conductivity values assigned in the Cleath and Associates model (Cleath and Associates, 1996a, 1997; 1998; ESA 1998) along the coastal margin and along the Santa Maria River are significantly higher than available estimates from pumping tests and higher than values assigned to the Santa Maria Basin model (Luhdorff & Scalmanini, 2000). Particularly high values are assigned in the vicinity of Black Lake and the northwest corner of the model domain. The resulting model transmissivity (hydraulic conductivity times aquifer thickness) near the coast west of Nipomo Mesa is 9 times higher than in the Santa Maria Basin Model and 19 times higher than values used by DWR for water balance calculations. As a consequence, the model groundwater discharge rates to the sea may be as much as ten times too high and the decreases in groundwater levels toward the coast due to increases in pumping beneath Nipomo Mesa, perhaps ten times too low.

3.7 Sea Water Intrusion

The aquifer system of Nipomo Mesa and the Santa Maria Groundwater Basin is hydraulically continuous offshore beneath the ocean. In a typical coastal aquifer, freshwater discharges from the seafloor to a point where the interface between freshwater and saltwater intersects the seafloor. The interface slants inland and downward and its geometry is controlled by density differences, hydraulic gradient within the freshwater portion of the aquifer, and distribution of hydraulic conductivity of the aquifer system. Figure 16 shows a conceptual model of a freshwater-saltwater interface for an idealized homogeneous coastal aquifer.

3.7.1 Idealized Freshwater/Saltwater Interface

Assuming steady-state horizontal flow in the freshwater (brackish) region and no flow in the saltwater region, the estimated depth below sea level of a sharp freshwater-saltwater interface in a confined aquifer can be calculated with the following equation (p. 385, Bear, 1979):

$$h_s = [P_f / (P_s - P_f)]\, h_f$$

where h_s is the depth to the interface below sea level, P_f is the density of the freshwater, P_s is the density of the seawater, and h_f is the freshwater head. For density values of 1 g/cc for fresh water and 1.025 for seawater the equation is:

$$h_s = [1/ (1.025-1)]\, h_f = 40\, h_f$$

For a typical hydraulic gradient of 0.00143 between the Nipomo Mesa and the coastline we calculate saltwater interface in an idealized homogeneous aquifer as shown on Figure 17. If the depth of the freshwater/saltwater interface is known near the coastline, Figure 17 provides insight to the hypothetical distance offshore of the freshwater/saltwater groundwater interface. Reports of poor groundwater quality in the Careaga Sands at depths greater than 700 feet near the coast (e.g. Dames and Moore, 1991) would suggest that the offshore interface might intersect the seafloor at a distance on the order of 12,000 feet.

3.7.2 Coastal Margin Monitoring Wells

In the 1960s and 70s, a total of seven monitoring wells were installed near the coast to monitor hydraulic head, water quality, and test for evidence of salt water intrusion, and provide an early warning if saltwater intrusion reaches the coastline. Figure 18 shows the location of the coastal margin monitoring wells that serve as sentries for salt-water intrusion. Most of these monitoring wells consist of several piezometers screened at different depths.

Water samples collected twice per year from these wells show no clear evidence of salt-water intrusion. Generally the hydraulic gradient has remained westward near the coast. However, concern regarding potential for salt-water intrusion is based on interpretation that the Careaga Sand is exposed on the sea floor several miles west of the coastline, and there are no known barriers to salt water intrusion.

With the exception of a couple of the shallow screens, which either have poor seals between the surface or intercepted local perched brackish water, chloride concentrations in all of the piezometers are well below the MCL of 250 mg/l for chloride in drinking water, which is nearly two orders of magnitude less than the concentration of chloride in sea water (20,000 mg/l).

The two highest concentrations of chloride in deep piezometers are 95 mg/l at a depth of 720-730 in monitoring well 11N/36W-12C, which is on the coastline west of Black Lake, and 125 mg/l at depth of 535-545 in MW 12N/36W-36L, which is a couple of miles further north. These relatively elevated chloride levels might be indicative of shoreward advancement of the seawater interface. Approximately 2.5 miles inland, groundwater levels in production well 11N35W20E001S, which is southwest of Nipomo Mesa, were pumped down to 40 feet below sea level in the 1940s to 1950s, and down to 80 feet below sea level for several years in the early 1970s (Figure 19). Potential seawater intrusion as a consequence of this pumping may occur beneath the coastline several decades after this pumping. Groundwater modeling discussed below helps to assess likely lag-times between inland pumping and potential seawater intrusion of the aquifer.

3.7.3 Modeling to Evaluate Potential Salt Water Intrusion

We developed groundwater flow and chemical transport models for use as tools to help evaluate potential seawater intrusion. Specifically, the models were used to evaluate time lapse between heavy inland pumping and changes in aquifer hydraulic head, groundwater discharge, and increases in groundwater salinity in the aquifer beneath the coastal margin. Summary descriptions of the model designs are provided in Appendix D.

Results of a simplistic MODFLOW/MT3D (McDonald and Harbaugh, 1988; Zheng, 1990, 1999) flow and transport model show a lag time of many decades between the onset of pumping 15,000 feet inland and increase in chloride concentration in groundwater beneath the coastal margin even when pumping only lasts for 5 years (Figure 20). For this model, however, the initial position of the freshwater/saltwater interface is assumed to be coincident with the sea floor. If the interface were further inland, the increase in salinity would occur more rapidly.

A second set of models was run using SEAWAT (Guo and Langevin, 2002), which is a specialized version of MODFLOW/MT3D that also accounts for variable fluid density. Appendix D provides a summary of the SEAWAT modeling. Model inflow includes constant head at upland margin and uniform recharge of 4 inches per year (25% of average rainfall).

First, the model was run without any pumping to achieve an equilibrium position for the saltwater-freshwater interface. Then a range of pumping rates were simulated at a distance of 15,000 feet inland using the non-pumping equilibrium initial condition for each case. Figure 21 shows a series of cross-sections of a coastal margin aquifer that illustrate the model equilibrium salinity distribution for a range of pumping rates. These model results show significant saltwater intrusion when the pumping rate exceeds 60% of the total inflow.

Figure 22 shows model increase with time of salinity in groundwater for a range of depths at distance of 3000 feet from the coastline as a consequence of pumping 15,000 feet inland at 70 percent of the total inflow. The model pumping well is screened between 100 and 600 feet below the static water table.

The models are simplistic tools and do not account for heterogeneity of hydraulic conductivity in the aquifer system that we know occurs. Relatively high permeability preferential pathways could exist within the aquifer and result in saltwater intrusion occurring more quickly than the models suggest. On the other hand, the two-dimensional cross-section nature of the modeling overestimates the response beneath the coastline to inland pumping because the model design does not allow for any groundwater inflow from the north or south. This is equivalent to assuming that uniform pumping occurs all along the coast and no groundwater flow occurs parallel to the coastline.

The model results are not intended to represent reality, or to predict the future, but they help evaluate time frame and sensitivity with depth for potential increases in salinity associated with seawater intrusion. For example, the models results suggest that drawdown of water levels to 80 feet below sea level due to heavy pumping a few miles inland 30 years ago, may still result in saltwater intrusion in the future. The modeling also suggests that pumping rates less than 50 percent of the total inflow (from percolation and subsurface flow) may not lead to significant degradation of groundwater quality in the coastal aquifer, but that pumping rates exceeding 50 percent of the total inflow may. In addition, pumping can induce upward flow of saline groundwater at depth.

Section 4
Conclusions and Recommendations

Evaluation of long historical records of groundwater levels and rainfall in the Santa Maria River Valley indicates that a 25-year period (1945-1970) with 2 inches less than average annual rainfall resulted in major decline of groundwater levels in the Santa Maria River Valley. Based on the 117-year rainfall record, the probability is approximately 30 percent that a 10-year period with 2 inches less than average annual rainfall will occur in the one hundred years resulting in major decline in groundwater levels again in the Santa Maria River Valley. Because of increased groundwater demand compared to the period from 1945 to 1970, the depletion of groundwater storage and resulting problems would likely be greater than before.

The aquifer system beneath Nipomo Mesa is contiguous with the Santa Maria River Valley and groundwater flow from the Santa Maria River Valley toward Nipomo Mesa constitutes a significant portion of the inflow to the Nipomo Mesa groundwater budget (including rainfall). Reported estimates of the contribution from Santa Maria River Valley range from approximately 35 percent (DWR, 2002) to 50 percent (Cleath & Associates, 1996a). A major decline of groundwater levels in the Santa Maria River Valley would decrease subsurface inflow to the Nipomo Mesa area.

Estimates by DWR (2002) of water budget deficits for the Nipomo Mesa Area during the period from 1975 to 1995 appear to be reasonable and agree well with a deficit estimated for a similar time period by Cleath and Associates (1996a). While modeling by Cleath and Associates (1996a, 1997, 1998, 2001) may provide reasonable assessments of future additional impact to groundwater by a development project, some of the model simulations do not provide realistic estimates of future groundwater conditions because the future simulations have neither provision for increased demand elsewhere in the basin, nor prolonged periods with less than average rainfall. Assigned transmissivity along the coastal margin in the Cleath and Associates model appears to be substantially too high and likely results in underestimates of water level decline near the coast and potential for saltwater intrusion. Decrease of transmissivities assigned to the model near the coast, incorporation in the model of projected general increases in demand for other portions of the groundwater basin in addition to specific proposed projects, and simulations designed to evaluate the effect of a series of several years with less than average rainfall would help to improve the model as a tool to assess the groundwater resource capacity of Nipomo Mesa.

Although the highly permeable dune deposits of Nipomo Mesa facilitates a high rate of infiltration of rainfall on the Mesa, fine-grained intervals within the dunes and in the upper portion of the Paso Robles Formation intercept a portion of the deep percolating water. This perched groundwater flows along these low-permeablity layers and discharges into Black Lake Canyon and the other systems of coastal drainages and lakes west of Nipomo Mesa. Groundwater modeling and water budget calculations that neglect discharge of the perched shallow groundwater likely overestimate recharge rates to the main aquifer beneath Nipomo Mesa.

The DWR 2002 report "*refrains from finding that the Santa Maria Groudwater Basin within San Luis Obispo County is currently in overdraft because of consistent subsurface outflow to the ocean and no evidence of sea water intrusion*" (pg 155, DWR, 2002). This statement by DWR is inconsistent with their definition of overdraft (e.g. pg 154 DWR 2002): "*the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which water supply conditions approximate average conditions.*" Based on this definition, since current and projected pumping beneath Nipomo Mesa exceeds inflow (recharge plus subsurface inflow), the Nipomo Mesa portion of the Santa Maria Groundwater Basin is currently in overdraft and projections indicate increasing overdraft.

By year 2025, projection of outflow exceeds the highest of a range of inflow estimates by 20 percent. This substantial overdraft and mining of groundwater in storage, will likely be accompanied by reduced production capability from many wells, increased energy costs for pumping, reduction of groundwater discharge to the coastal drainages and lakes west of Nipomo Mesa, and increased risk of seawater intrusion of the aquifers near the coastal margin.

DWR's (2002) reported finding of "*consistent subsurface outflow to the ocean and no evidence of sea water intrusion*" does not preclude the existence of overdraft conditions. DWR's definition of overdraft, which is provided two paragraphs above, is simply that pumping exceeds recharge over a period of years with approximately average conditions. Indeed it is possible for consistent subsurface outflow to the ocean to persist for decades despite concurrent overdraft conditions in an inland portion of the same groundwater basin. In addition, although we agree that seawater intrusion is not yet evident based on data from the coastal monitoring wells, the basis for consistent subsurface outflow from the aquifers to the ocean is tenuous. The DWR's water budget analysis for the Nipomo Mesa area (Table 26, DWR 2002) indicates that for both the base study period (1984-1995) and for 2020 projections the best estimate of subsurface outflow to the ocean is in the range of only 8 to 9 percent of the total inflow including recharge from average rainfall. This indicates that consistent subsurface outflow to the ocean from the aquifers beneath the Nipomo Mesa Area is vulnerable to small proportional increases in groundwater withdrawal from Nipomo Mesa, or reductions in inflow, for example a prolonged period of low rainfall or increased pumping in Santa Maria Valley.

DWR's (2002) conclusions for the Nipomo Mesa area study seem to confuse assessment of water resource capacity and manifestation of exceeding dependable yield. The DWR analyses, projections, and water budget estimates clearly indicate that groundwater pumping in the Nipomo Mesa area is in excess of the dependable yield and that overdraft conditions have existed and are expected in the future. Our analyses indicate that as a consequence of the buffering effect of depletion of groundwater in storage and slow rates of groundwater flow in the aquifers, a lag time of several decades is expected before overdraft conditions are manifested as seawater intrusion in the aquifers near the coast. Reduction of groundwater discharge to coastal drainages and lakes west of Nipomo Mesa is likely to be a relatively rapid consequence of continued overdraft conditions beneath the Nipomo Mesa.

The County's Resource Management System (RMS) defines three categories of levels of severity when water supply is exceeded by demand[8]. Based on a January 2000 draft version of the DWR report on the water resources of the Nipomo Area (DWR, 2002), the County General Plan recommended a Water Supply Level of Severity of II for the Nipomo Mesa Sub-Unit of the Santa Maria Groundwater Basin.

Analysis of the groundwater budget estimates reported by DWR (2002) for Nipomo Mesa shows outflow outpacing inflow (including estimates of recharge from average rainfall) since 1980. Projections to year 2025 show an increasing deficit, even when accounting for increasing influx of groundwater from Santa Maria River Valley due to increasing pumping beneath Nipomo Mesa. By year 2025, the estimated outflow exceeds even the highest of a range of inflow estimates by 20 percent. Thus, DWR's findings are consistent with a Level of Severity III RMS Water Supply Criterion for groundwater beneath the Nipomo Mesa Area.

Although existing and projected future water demand at Nipomo Mesa exceeds sustainable groundwater supply based on local water balance analyses, associated potential impact such as seawater intrusion of the aquifer system is not an imminent threat.

Reliable prediction of when seawater intrusion will significantly impact quality of water pumped from wells near the coastal margin is impossible. Important unknowns include

- historical and current location of the interface between freshwater and seawater in the aquifers offshore,
- when did/will the seawater intrusion clock start ticking? 1940s, 1970s, 2000?
- offshore aquifer geometry and degree of hydraulic connection between aquifers and the sea,
- high permeability preferential pathways for sea water intrusion such as faults or ancient river channel deposits.

Groundwater models cannot serve as crystal balls, but when designed as tools to assess implications of reasonable possibilities they are useful to evaluate alternatives for groundwater management and potential timing of seawater intrusion. A groundwater model developed as a resource management tool could also be used to assess possible progression of seawater intrusion.

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[8] County RMS water supply levels of severity:
I projected demand over the next nine years equals or exceeds estimated dependable supply.
II projected demand over the next seven years equals or exceeds estimated dependable supply.
III existing demand equals or exceeds the dependable supply.

Estimates of hydraulic gradient and changes in groundwater storage using water level contour maps by DWR (2002) are difficult to evaluate because the data points on which the contours are based are not included and the screen intervals and pumping status of the wells is not provided. Recent completion of work by the County on compiling historical data and upgrading the database of groundwater elevations will facilitate routine evaluation of hydraulic gradients and change in groundwater storage. Collaboration with Santa Barbara County to collect semi-annual water level data and produce annual monitoring reports is recommended to improve understanding to Santa Maria Groundwater Basin as a whole.

Continued efforts on Nipomo Mesa to increase the use of recycled water, such as for the irrigation of golf courses, will help to lessen impact of development on the rate of depletion of groundwater resources. Opportunities for conjunctive use of surface water and groundwater on the Nipomo Mesa are limited and expensive because of the lack of significant surface water on the Mesa and the distance and lift that would be required to pipe water in from outside the Mesa. Management of floodwater discharge from Cuyama River to the Santa Maria River with Twitchell dam has provided some enhancement of recharge to the aquifers of the Santa Maria River Valley. However, since water in the Santa Maria River nearly always infiltrates the subsurface before reaching the coast, there is little opportunity for additional enhancement of recharge along the river without an additional source of water. Basin management planning should also account for likely future decrease in recharge enhancement provided by flood water management at Twitchell Dam due to depletion of Cuyama river flows by heavy groundwater pumping in Cuyama Valley (DWR, 2003) and decrease in storage capacity with accumulation of sediment in Twitchell Reservoir (e.g. SAIC et al., 2003).

Importation of water to Santa Barbara County from the State Water Project (SWP) began in 1996; approximately 12,000 AF of SWP water were provided to the Santa Maria Groundwater Basin in 1999. Continued supply of SWP to the Santa Maria River Valley is important to help offset groundwater supply deficits for portions of both Santa Barbara and San Luis Counties. Perhaps the two Counties can work together to increase the SWP allotment to the Santa Maria River Valley. Desalinization of seawater is also an option for supplementary water supply for Nipomo Mesa, but is generally considered a very expensive, last resort option.

Water conservation measures and appropriate limits on development of the coastal communities are perhaps the most practical approaches for preventing sustained depletion of groundwater resources of Nipomo Mesa and the Santa Maria Groundwater Basin as a whole.

Section 5
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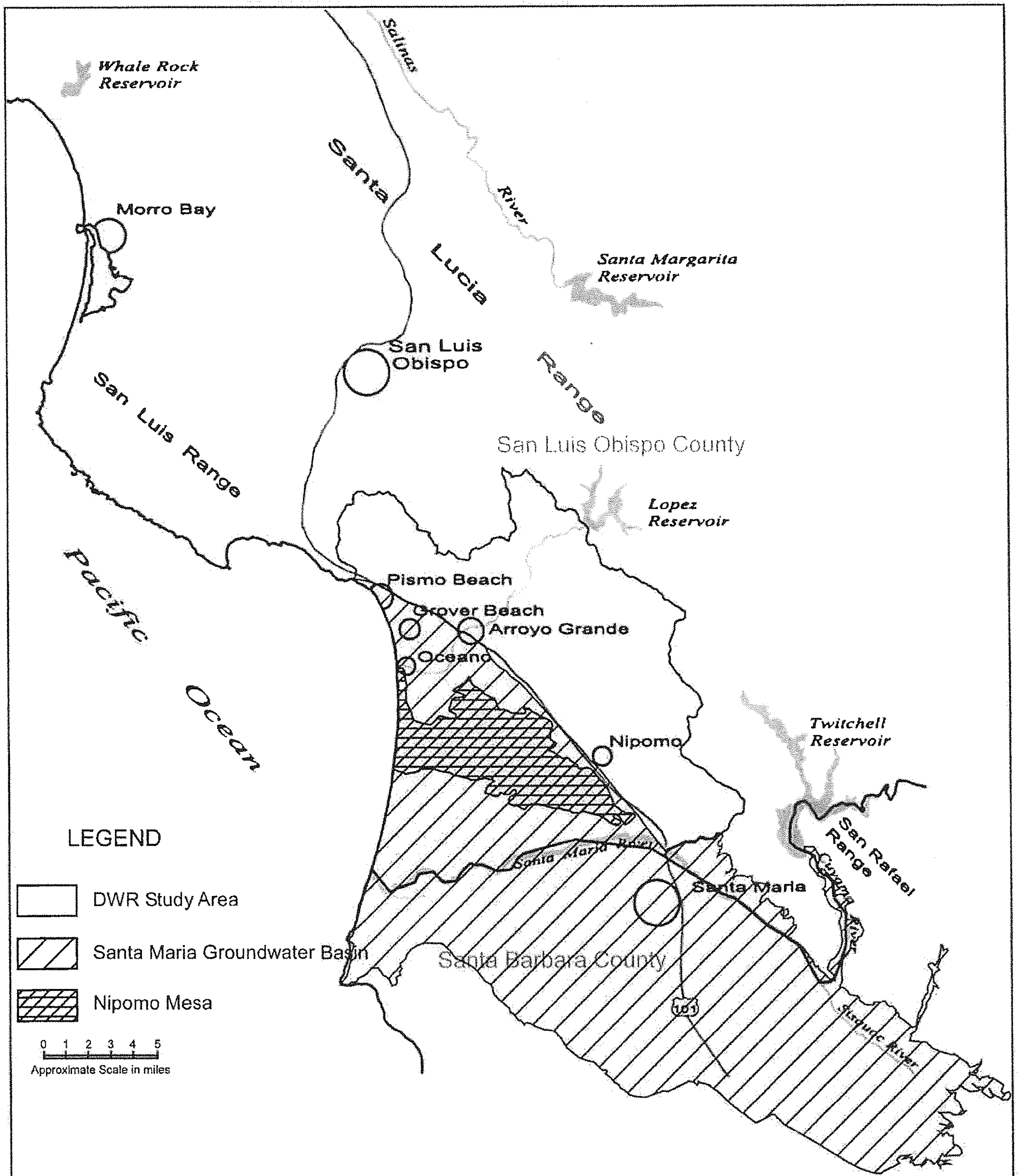
Figures

Appendices

Figures

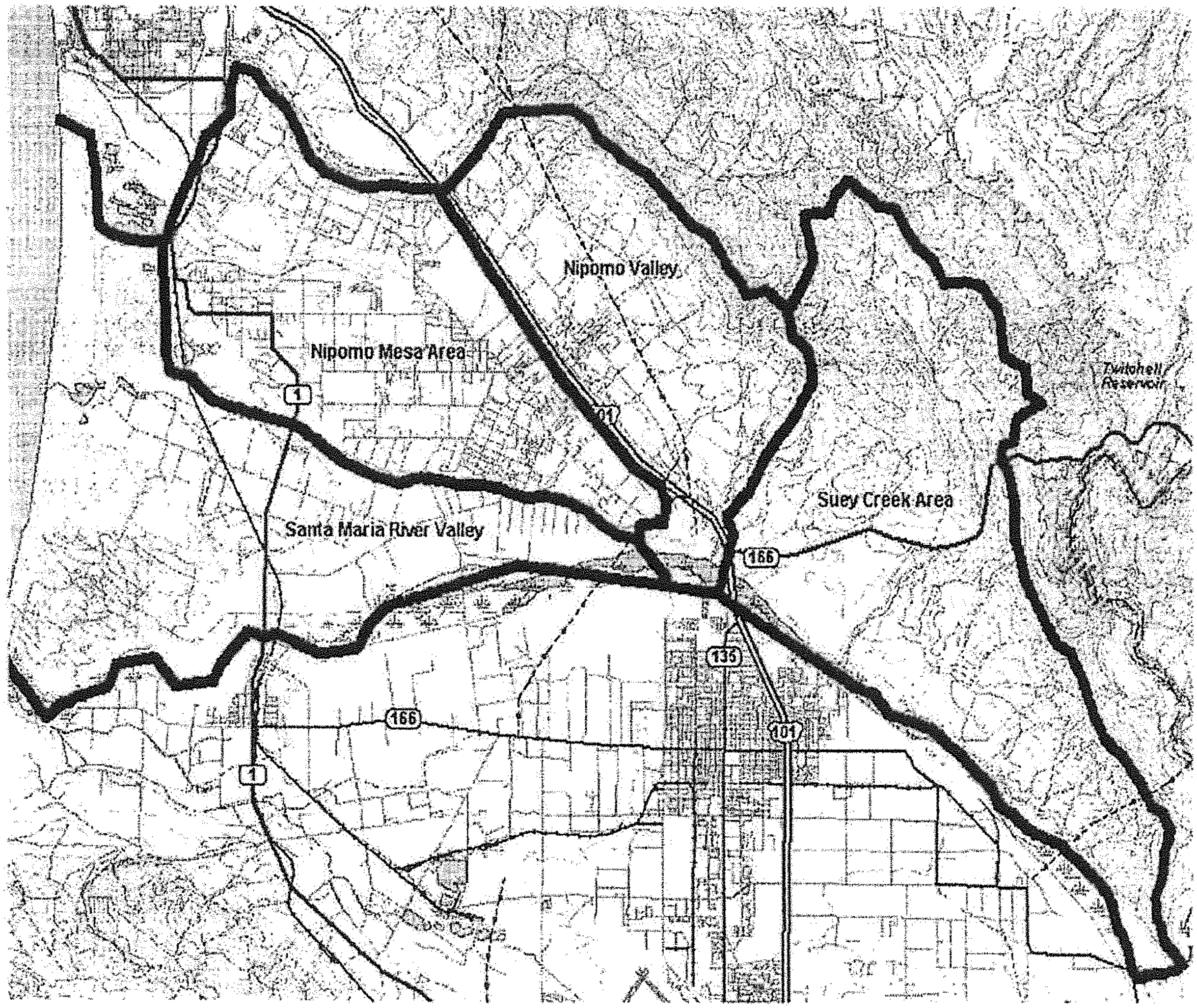
Appendices



Adapted from Figure 1 and Plate 1. DWR, 2002.

SITE LOCATION MAP
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 1



Adapted from San Luis Obispo County Master Water Plan Update, Phase II, January 2003

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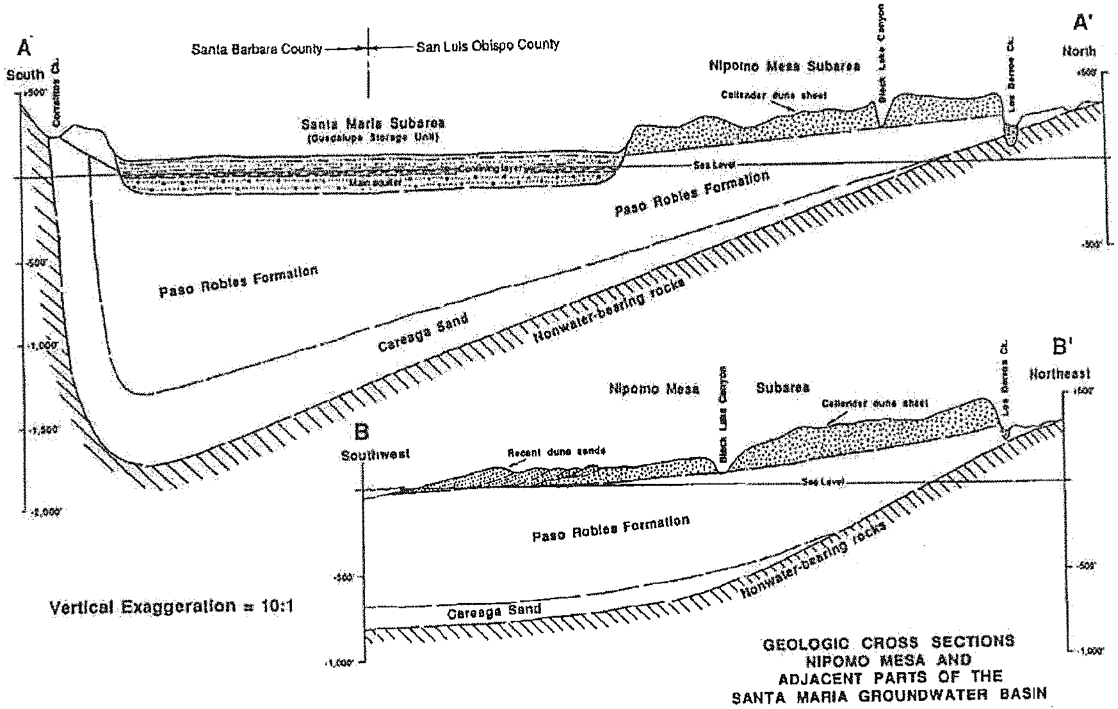
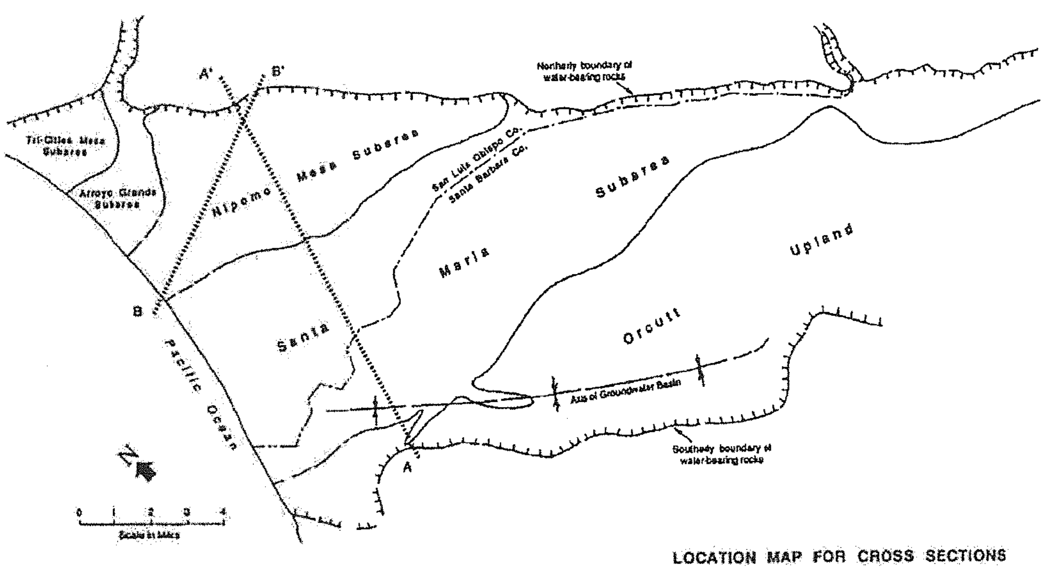
NIPOMO WATER PLANNING AREA (WPA6) AND SUBAREAS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 2

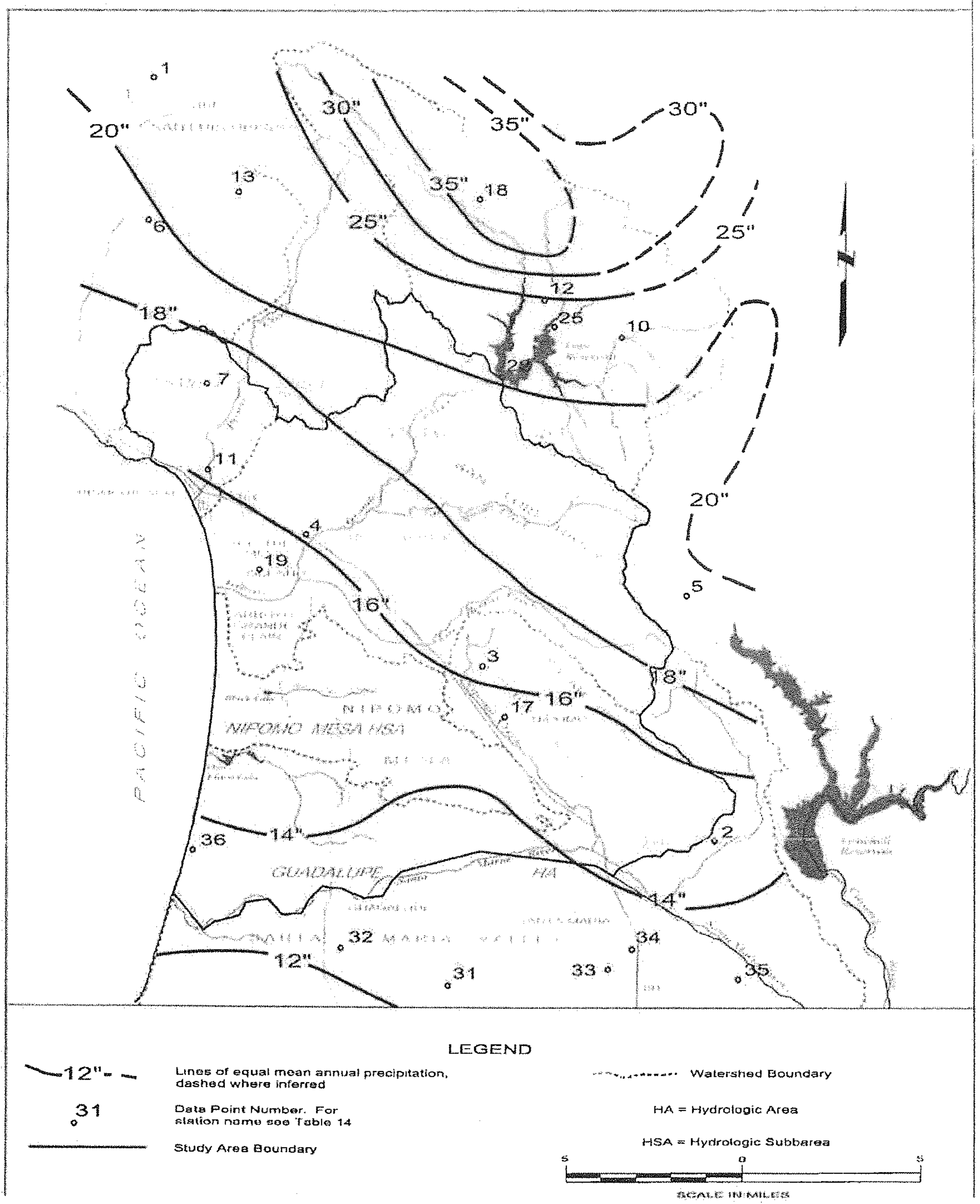




Adapted from Figures A-9 and A-10, Morro Group (July 1990)

CONCEPTUAL GEOLOGIC CROSS-SECTIONS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 3



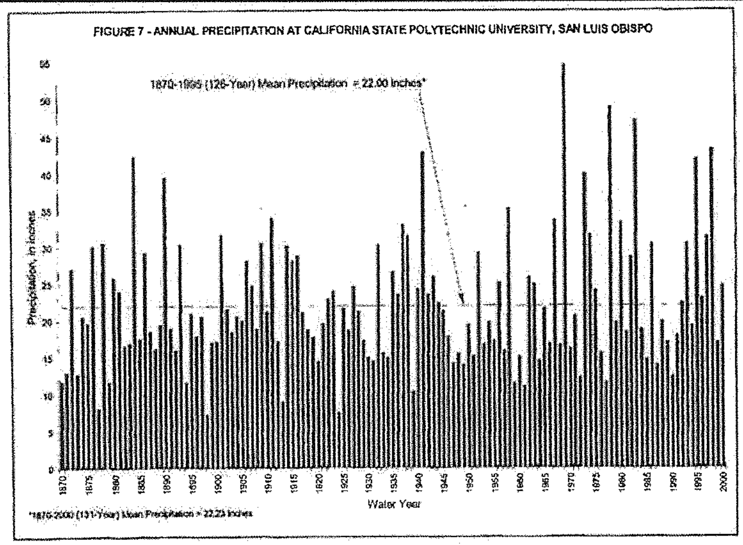
Adapted from Plate 8. DWR, 2002.

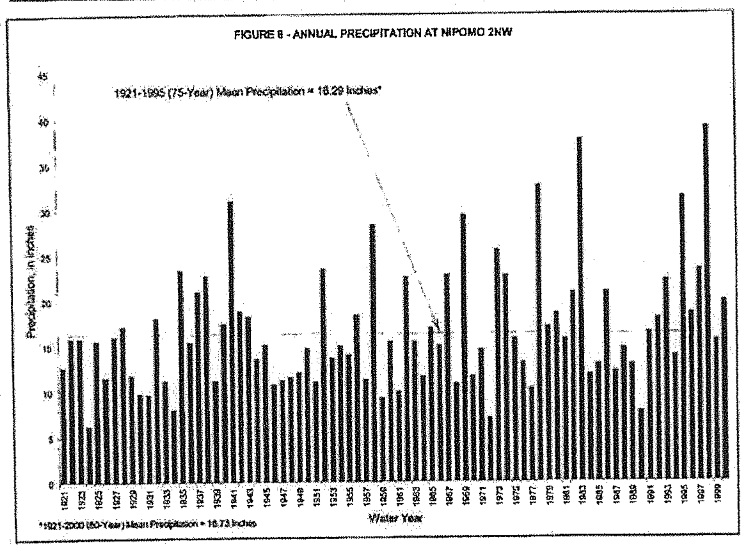
CONTOUR MAP OF EQUAL MEAN ANNUAL PRECIPITATION

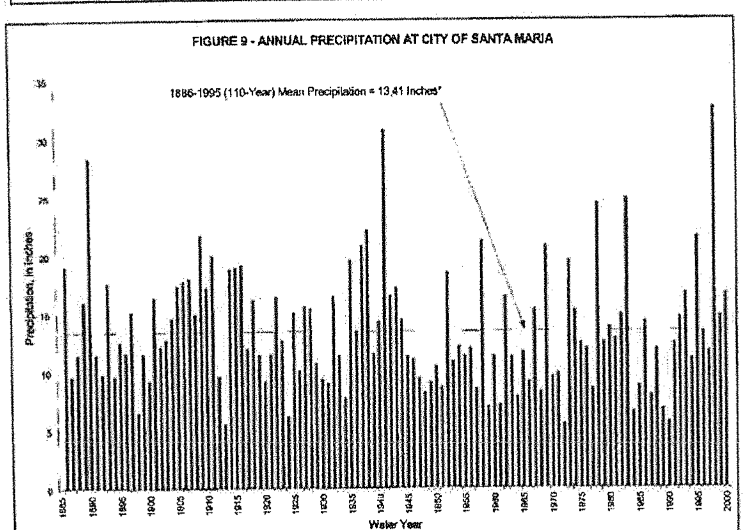
Nipomo Mesa Water Resource Capacity Study

San Luis Obispo County, California

Figure 4



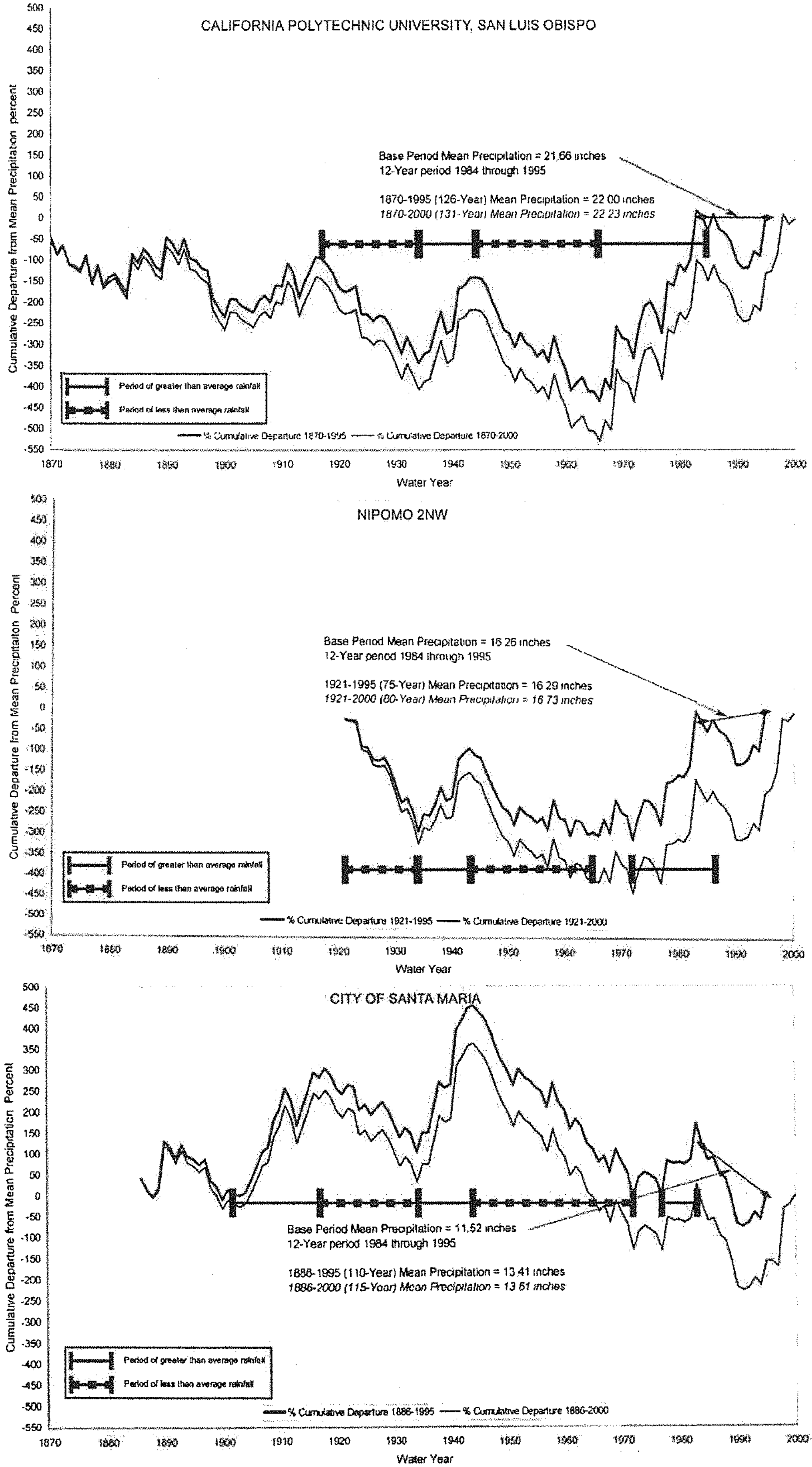




Adapted from Figures 7-9, DWR, 2002,

RAINFALL RECORDS (DWR, 2002)
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

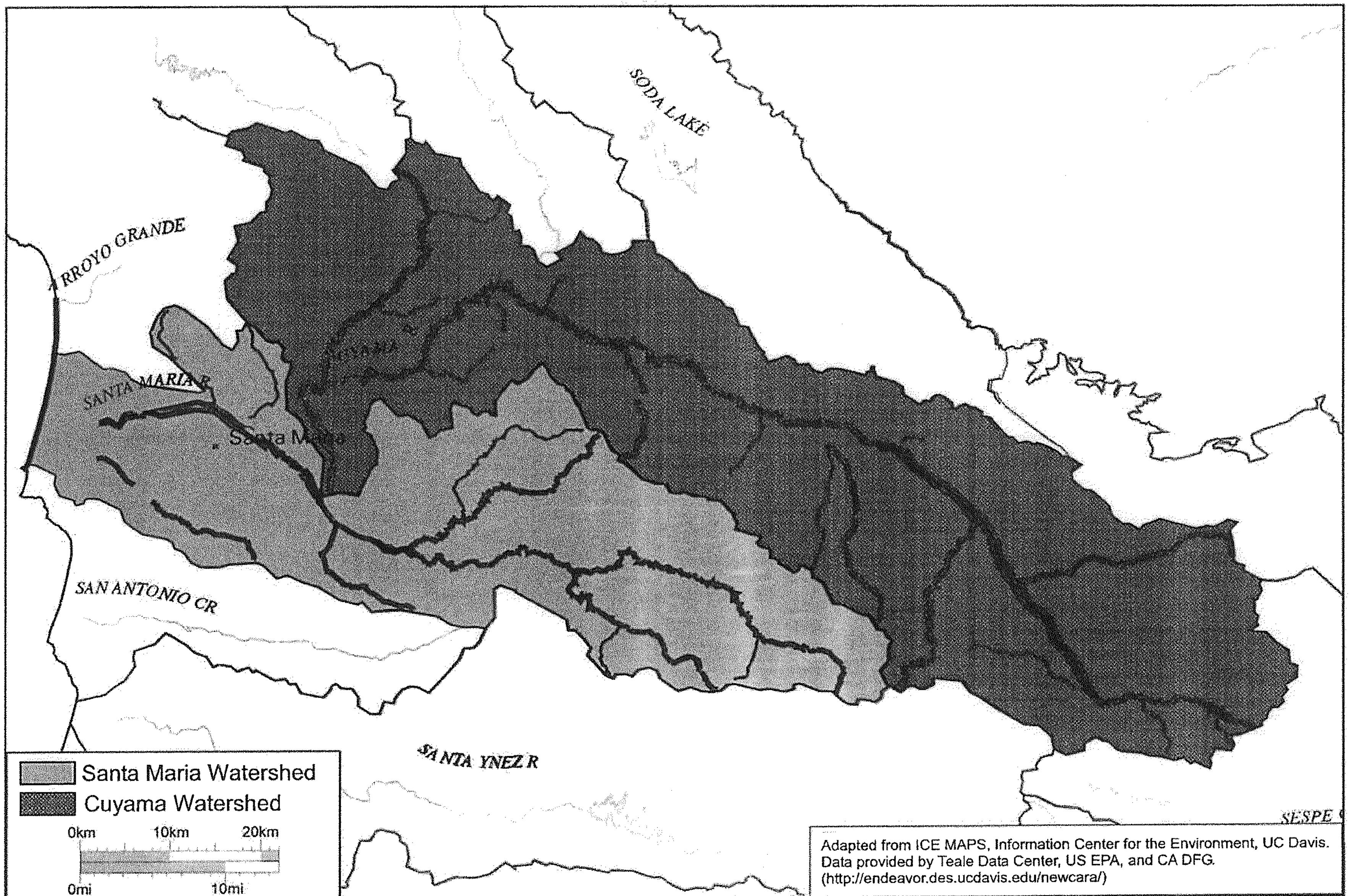
Figure 5



Adapted from Figures B1 - B3. DWR, 2002.

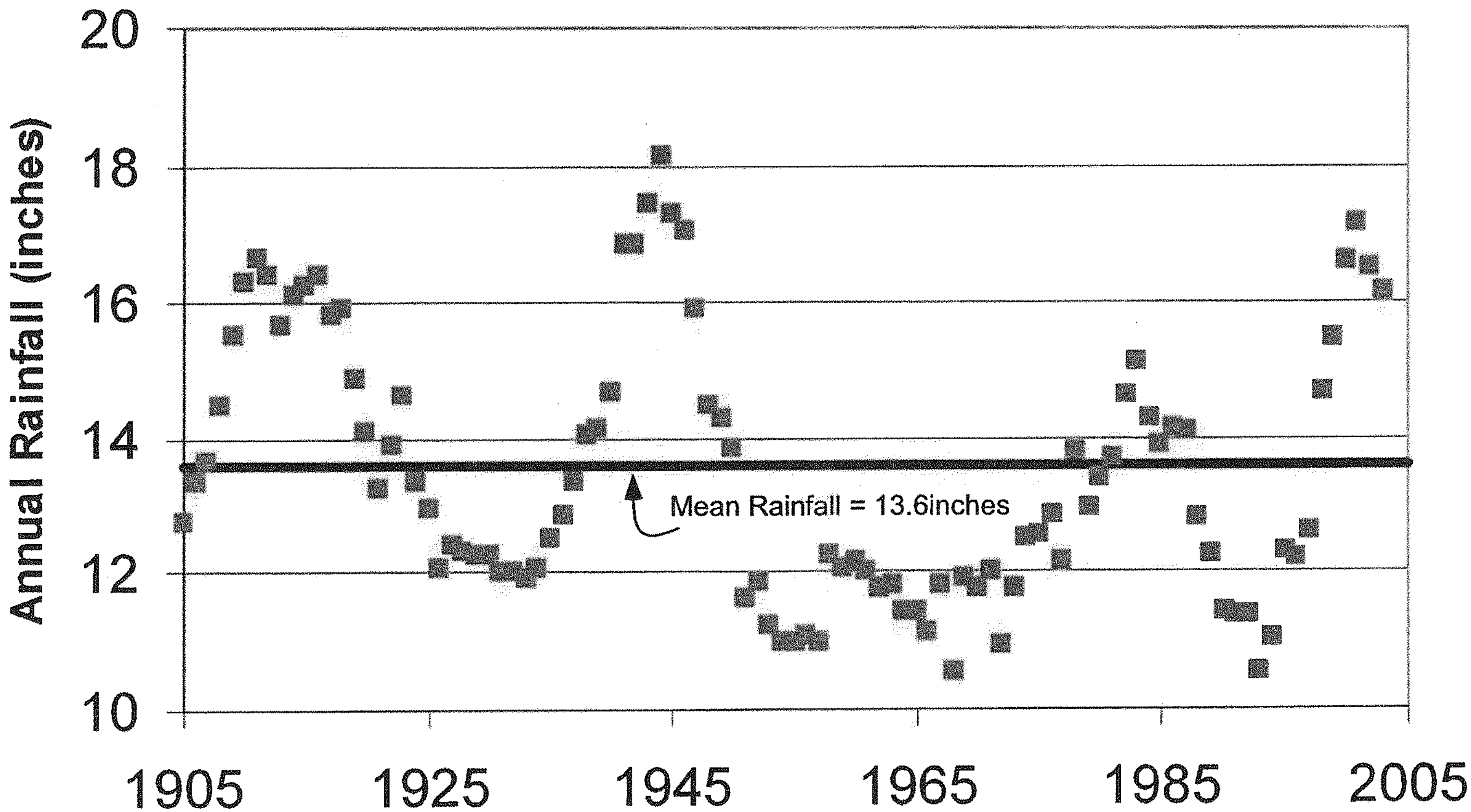
CUMULATIVE DEPARTURE FROM MEAN PRECIPITATION
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 6



SANTA MARIA AND CUYAMA WATERSHEDS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

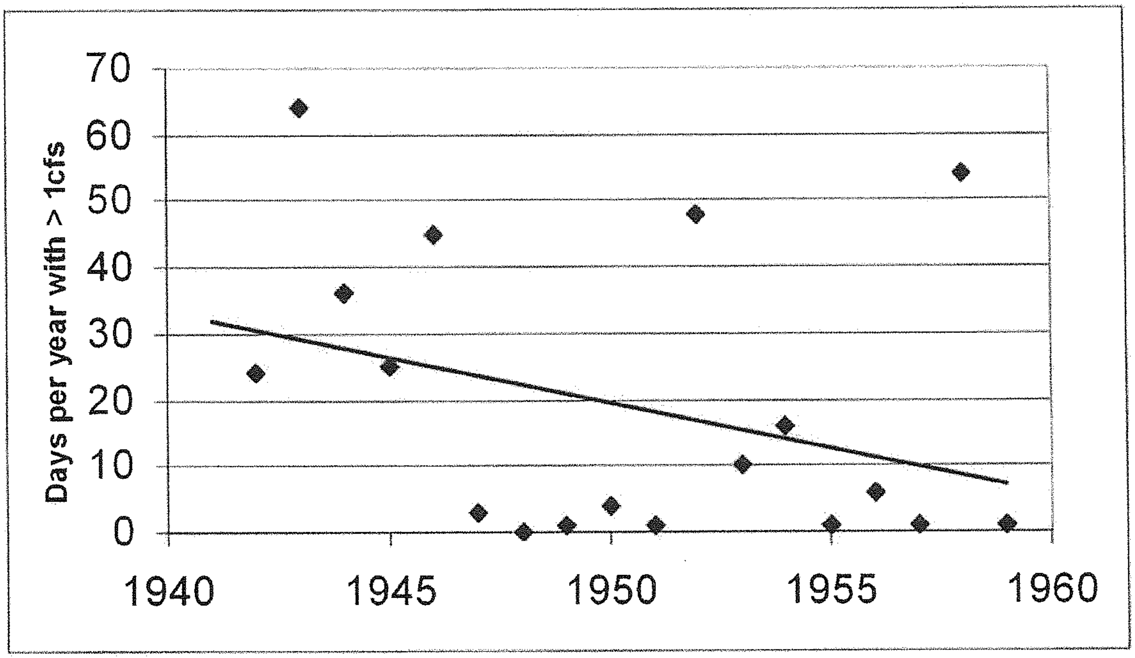
Figure 7



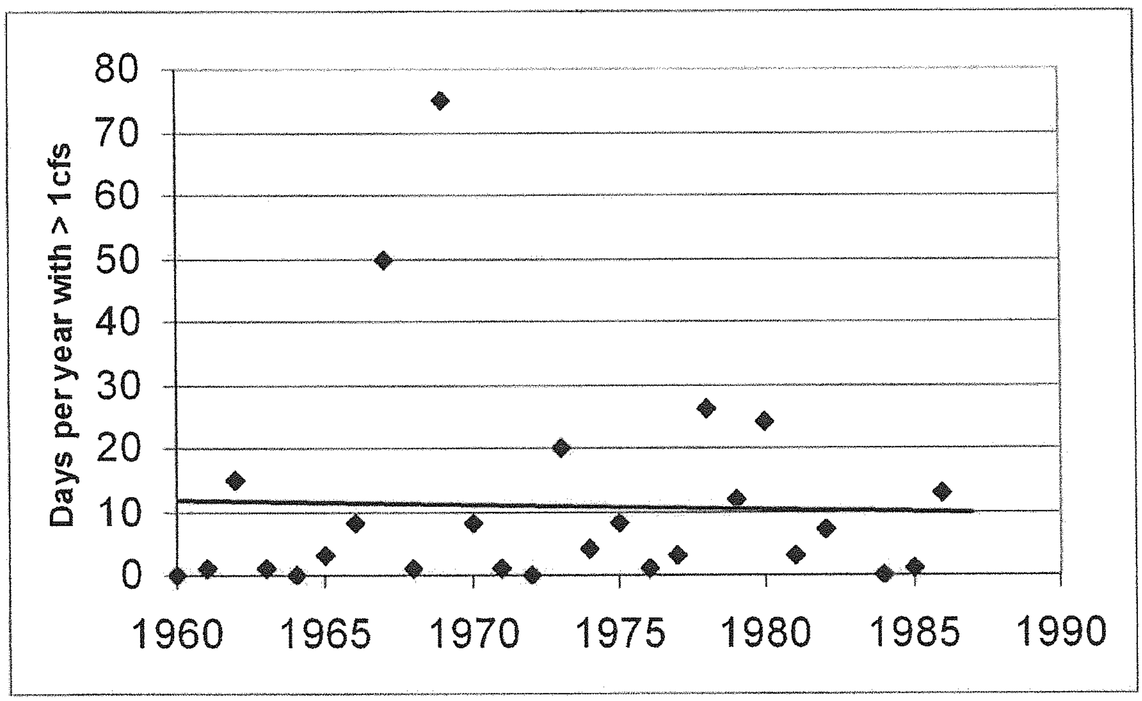
10-YEAR SLIDING WINDOW AVERAGE ANNUAL RAINFALL AT SANTA MARIA
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 8

Pre-Twitchell Dam



Post-Twitchell Dam



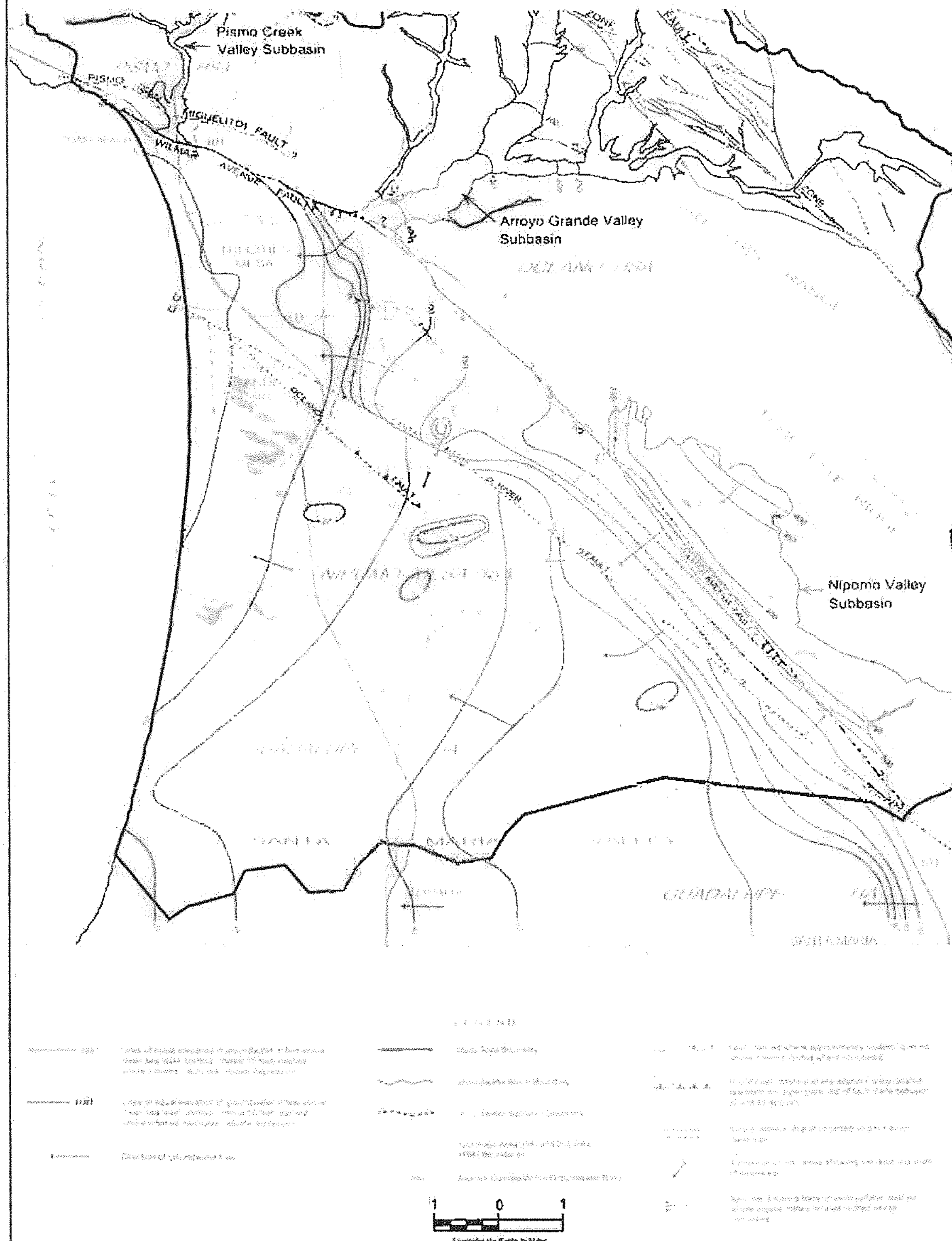
Notes:

1. Values exceeding the mean plus two standard deviations are considered outliers and were removed.
2. Pre-Twitchell Dam dataset illustrates decreasing trend in number of days per year that the Santa Maria River near Guadalupe was flowing.
3. Post-Twitchell Dam dataset shows a stabilized trend with an average of 10 days per year with water flowing in the River. This is a consequence of management of flows with the Twitchell Dam.

$\Sigma^2\Pi$

SANTA MARIA RIVER FLOW RATE NEAR GUADALUPE
NUMBER OF DAYS PER YEAR WITH FLOWS EXCEEDING 1 CFS (1941-1987)
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

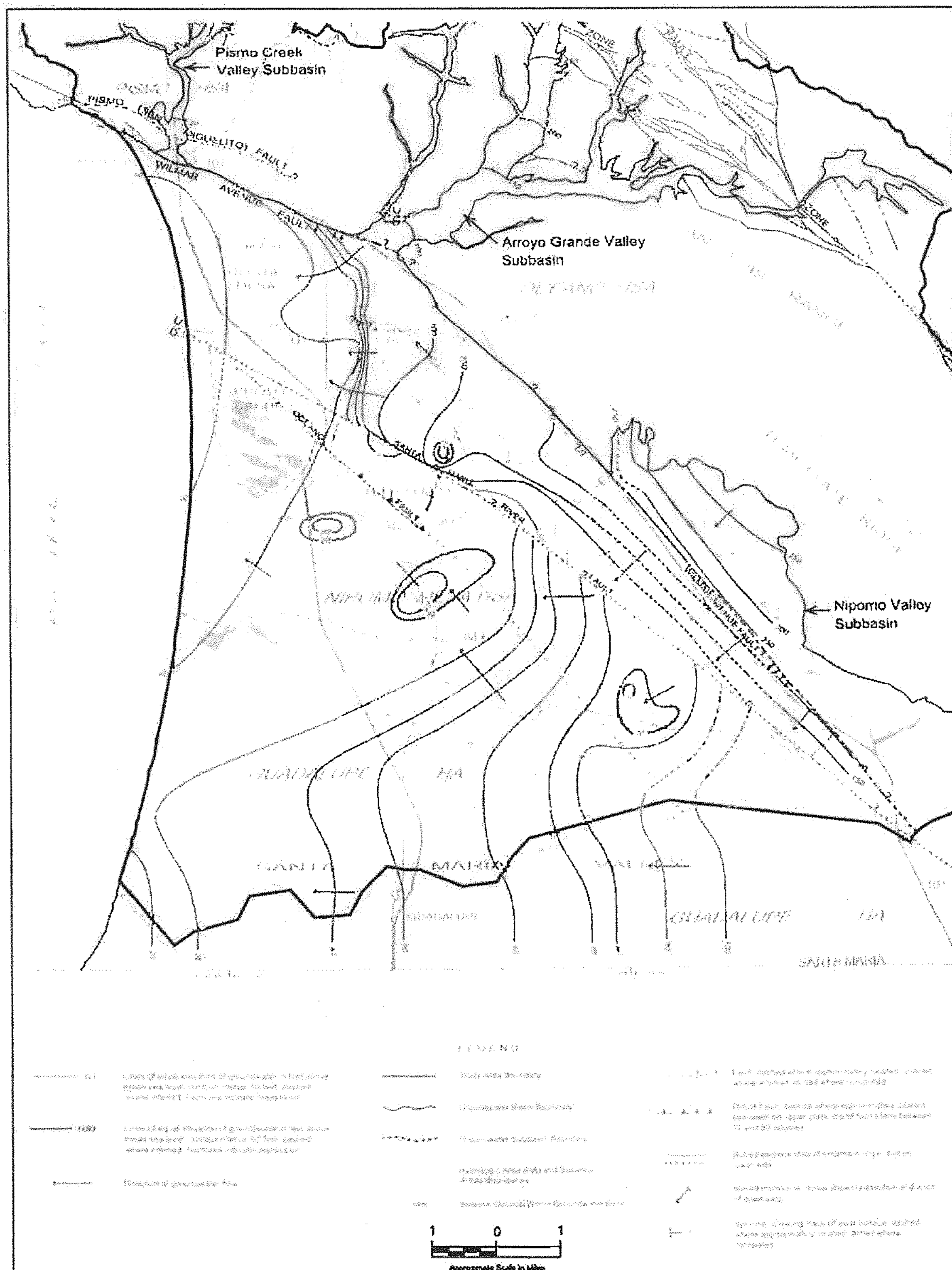
Figure 9



Adapted from Plate 12, DWR, 2002

SPRING 1975 GROUNDWATER ELEVATION CONTOURS (DWR, 2002)
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

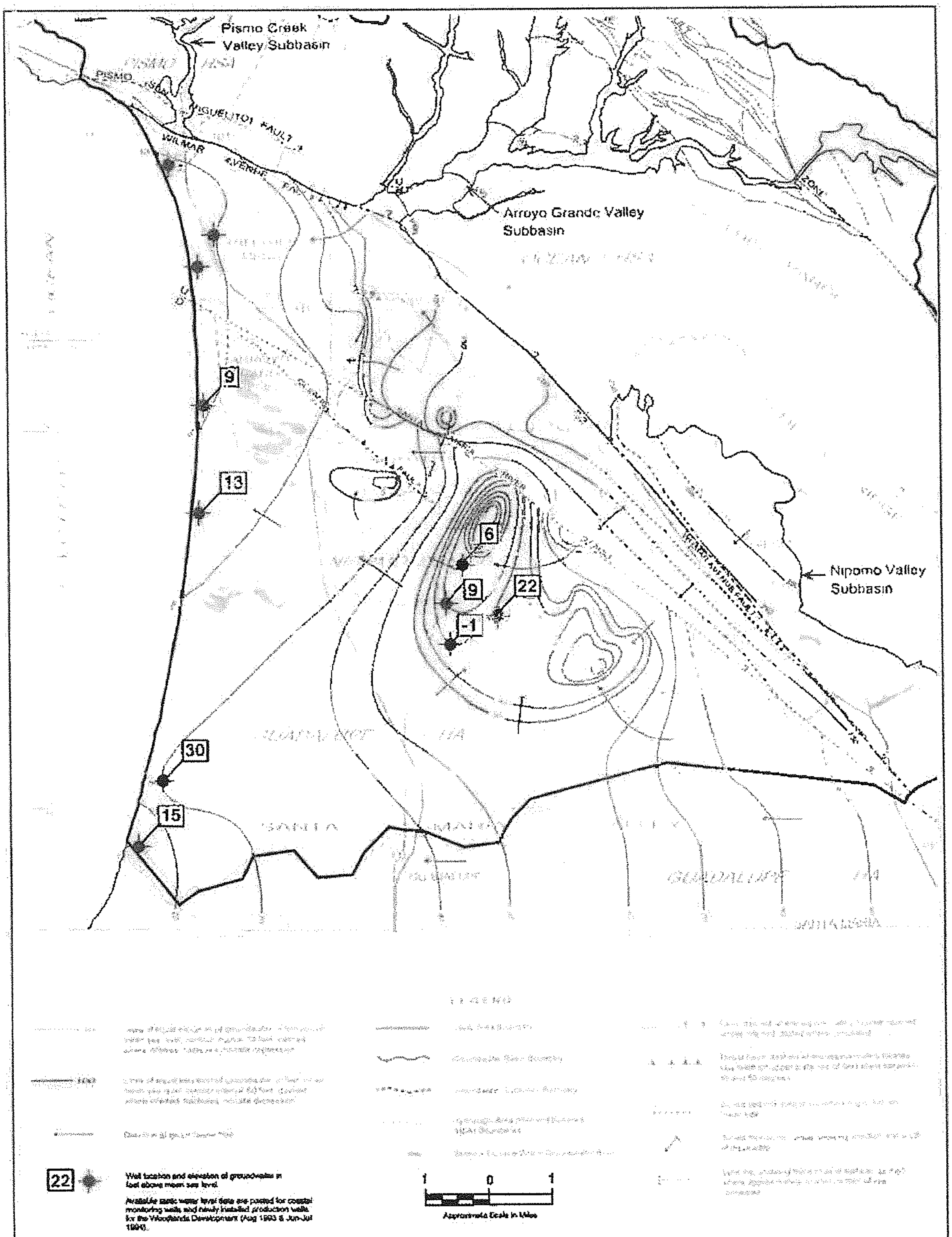
Figure 10



Adapted from Plate 13, DWR, 2002

SPRING 1985 GROUNDWATER ELEVATION CONTOURS (DWR, 2002)
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

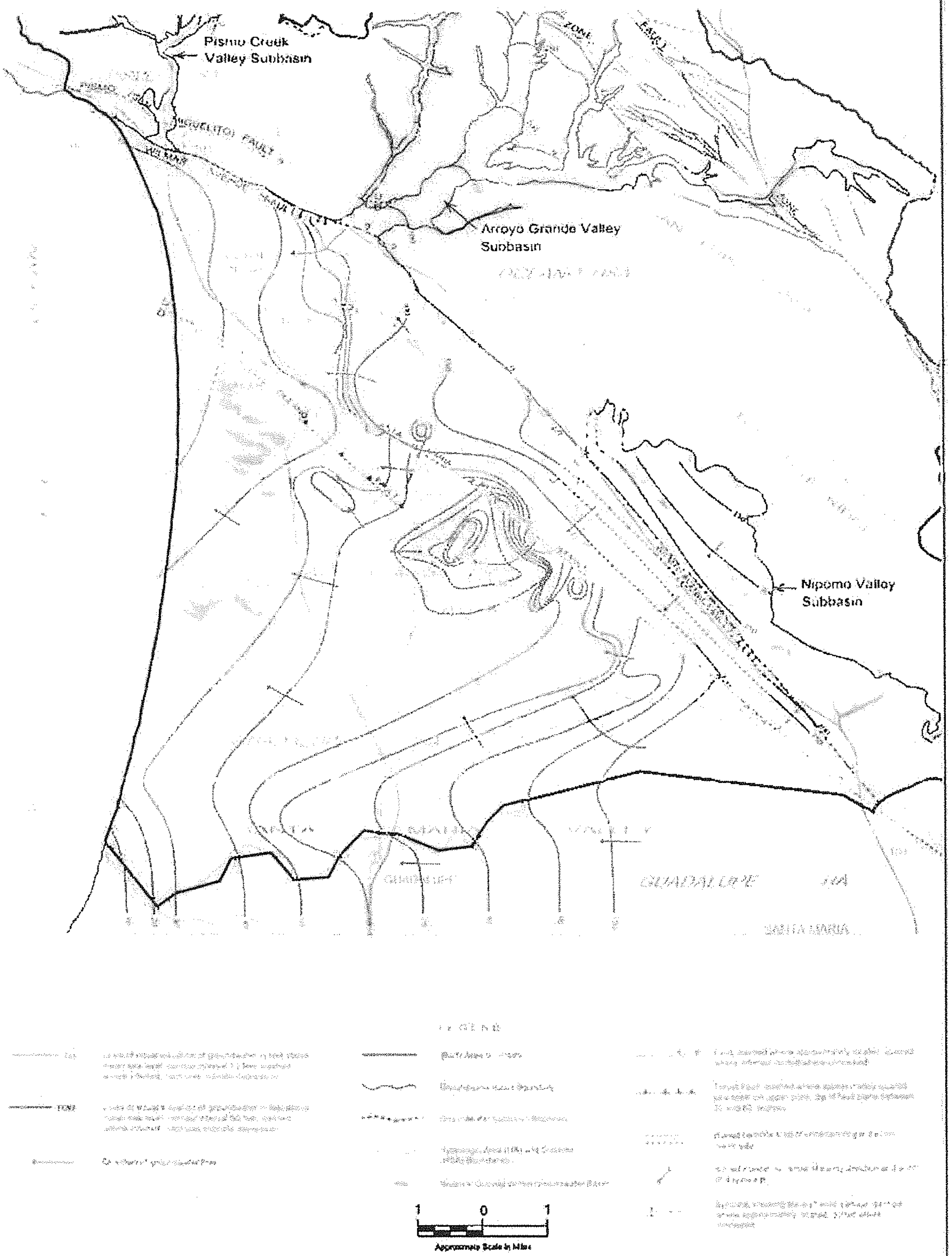
Figure 11



Adapted from Plate 14, DWR, 2002

SPRING 1995 GROUNDWATER ELEVATION CONTOURS (DWR, 2002)
AND WATER LEVEL DATA FROM SPECIFIC WELL LOCATIONS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

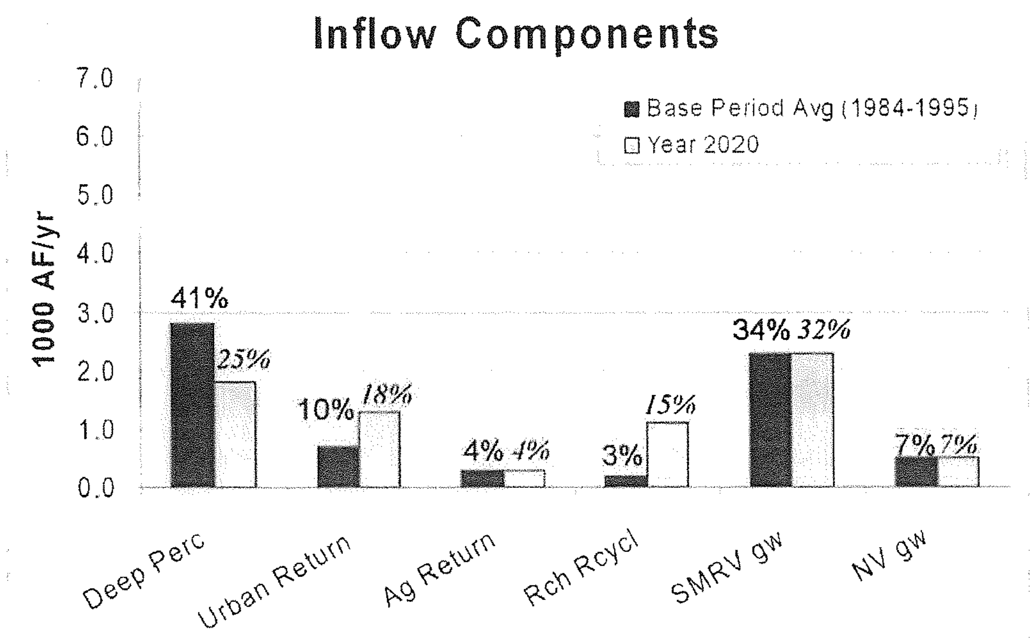
Figure 12

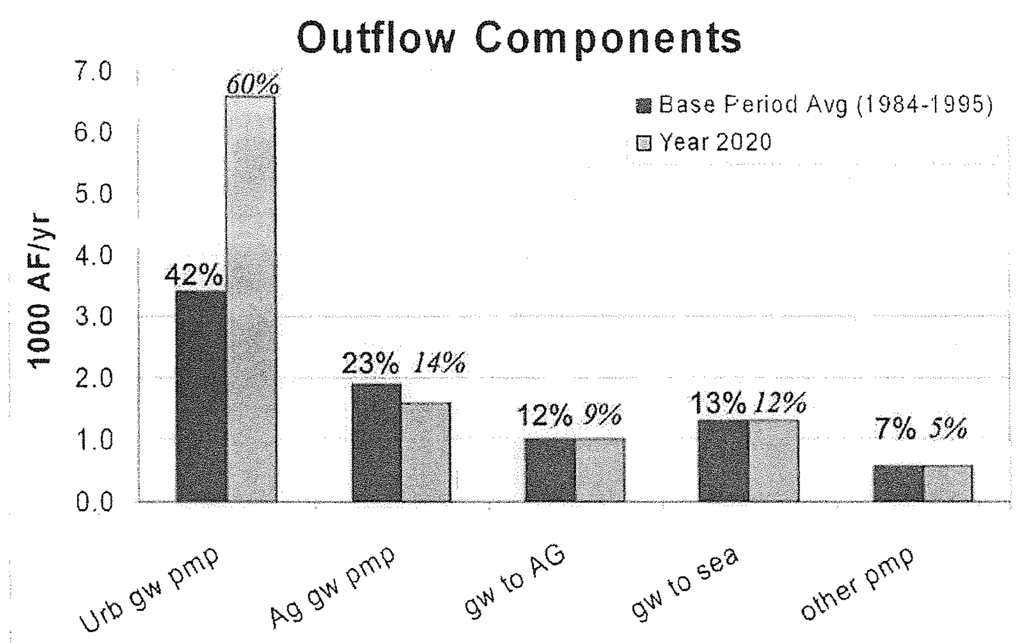


Adapted from Plate A1; DWR, 2002

SPRING 2000 GROUNDWATER ELEVATION CONTOURS (DWR, 2002)
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 13





Data Source: Table 26 (DWR, 2002)

Inflow Components: Deep percolation of precipitation; Urban Return; Ag Return; Recharge of Recycled Water; Groundwater flow from Santa Maria River Valley; Groundwater Flow from Nipomo Valley

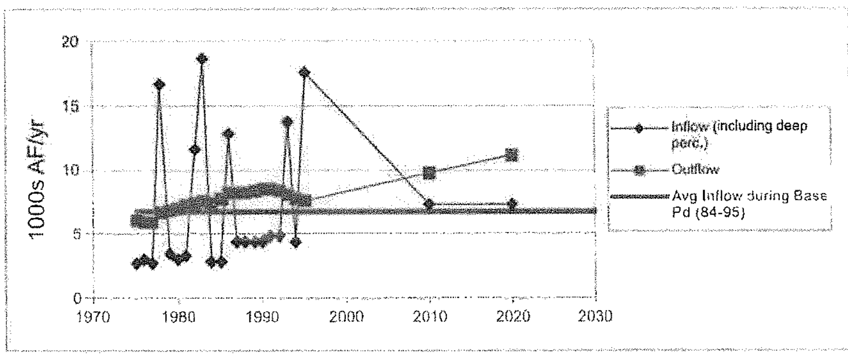
Outflow Components: Groundwater pumping for Urban Use; Groundwater pumping for Ag Use; Flow of groundwater to Tri-Cities Mesa - Arroyo Grande Plain; Flow of groundwater to Sea, Other pumping

$\Sigma^2\Pi$

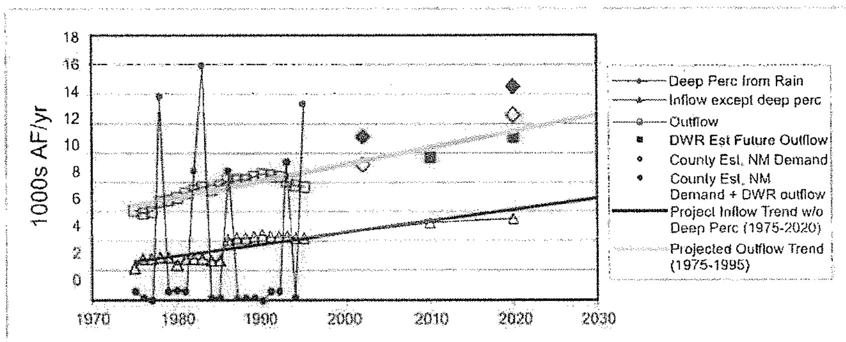
ESTIMATES BY DWR OF WATER BUDGET COMPONENTS FOR NIPOMO MESA
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 14

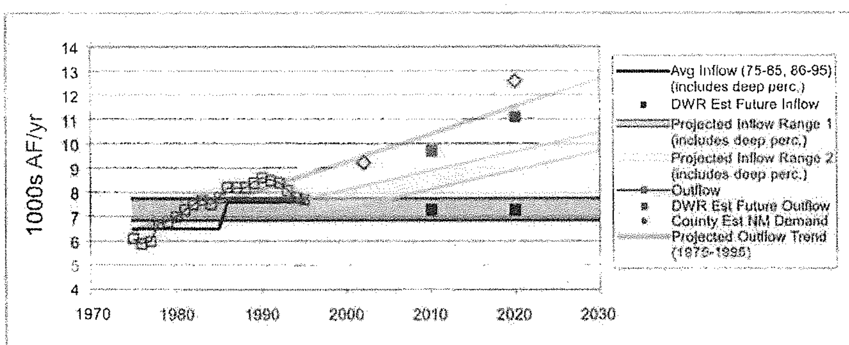
A.



B.



C.



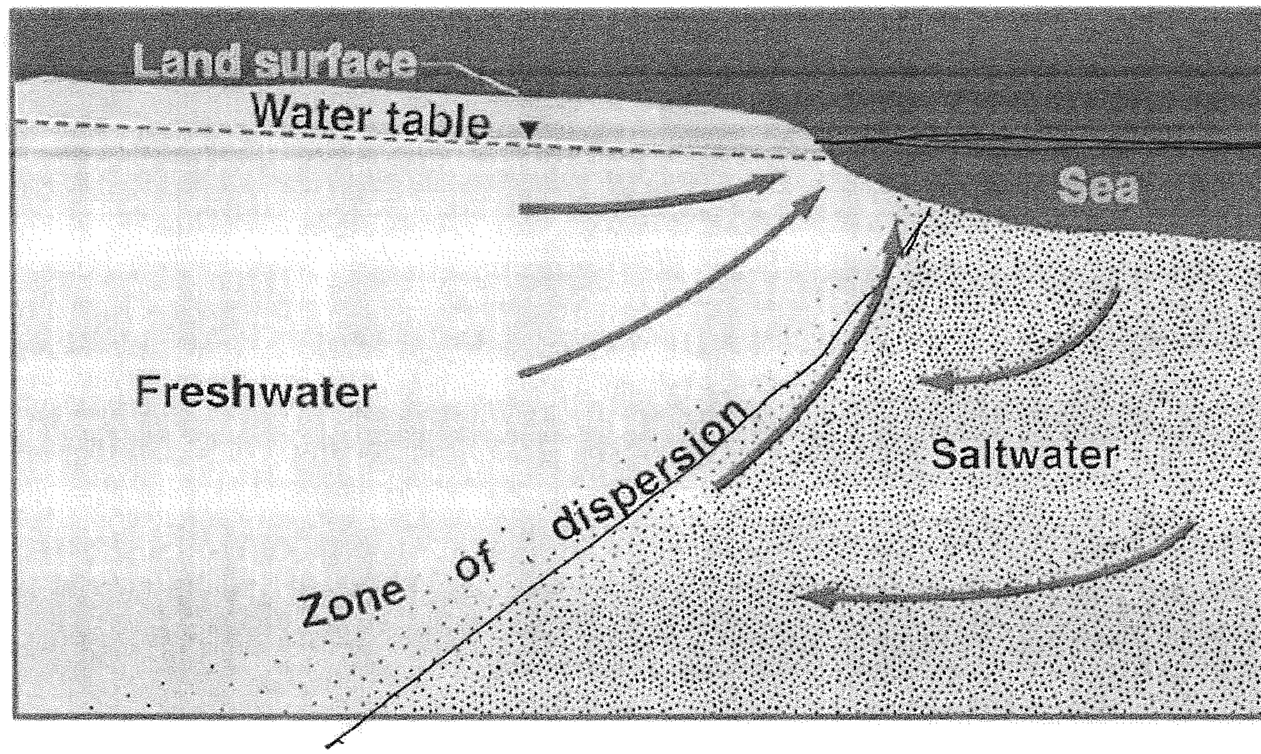
Notes:

Graph A shows estimates by DWR (2002) of annual values for total inflow and outflow for Nipomo Mesa for the 20-year period from 1975 to 1995 and projected estimates for years 2010 and 2020. Inflow includes deep percolation of rainfall, which is the reason for the large variation. Average annual inflow during the study base period (1984-1995) is also shown. This graph shows that DWR's estimates of total outflow have exceeded average inflow since 1980 with an apparent increase in deficit with time.

Graph B provides details for the components of the annual water budget annual by DWR (2002). Components of inflow other than deep percolation, 60 percent of which is groundwater inflow from Santa Maria River Valley, are more stable and show two nearly flat trends during the 20-year period of analysis: 1975 to 1985 and 1986 to 1995. We fitted a line through these data and the DWR inflow estimates for 2010 and 2020, which account for more subsurface inflow in response to greater hydraulic gradient toward Nipomo Mesa with increases in pumping.

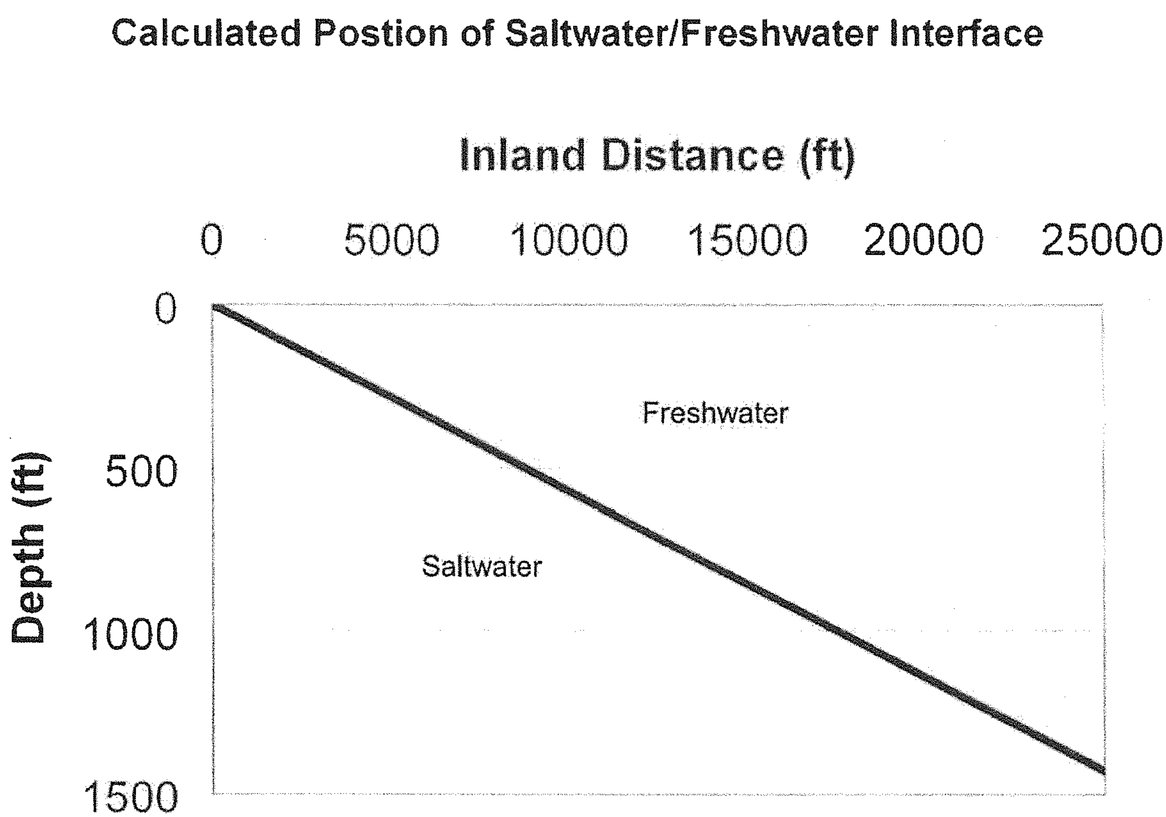
Graph B also shows a trend line fitted to the 20-year period of outflow values to provide an estimate of outflow rates in the future. DWR's estimated values of outflow for years 2010 and 2020 are close to this projected trend. The open diamond symbols are estimates of Nipomo Mesa water demand for years 2002 and 2020 from the County Master Water Plan Update (January, 2003). The filled diamond symbols at 2002 and 2020 are Nipomo Mesa demand estimates by the County with the DWR estimates subsurface outflow added (Table 26, DWR, 2002).

Graph C shows projected outflow and two ranges of estimated inflow to Nipomo Mesa based on DWR water budget components. One inflow range is constant with time. The other inflow range increases with time as a consequence of increase in rate of groundwater flow from Santa Maria Valley to Nipomo Mesa estimated by DWR (2002). Additional explanation is provided in the text of Section 4.4 to this report.



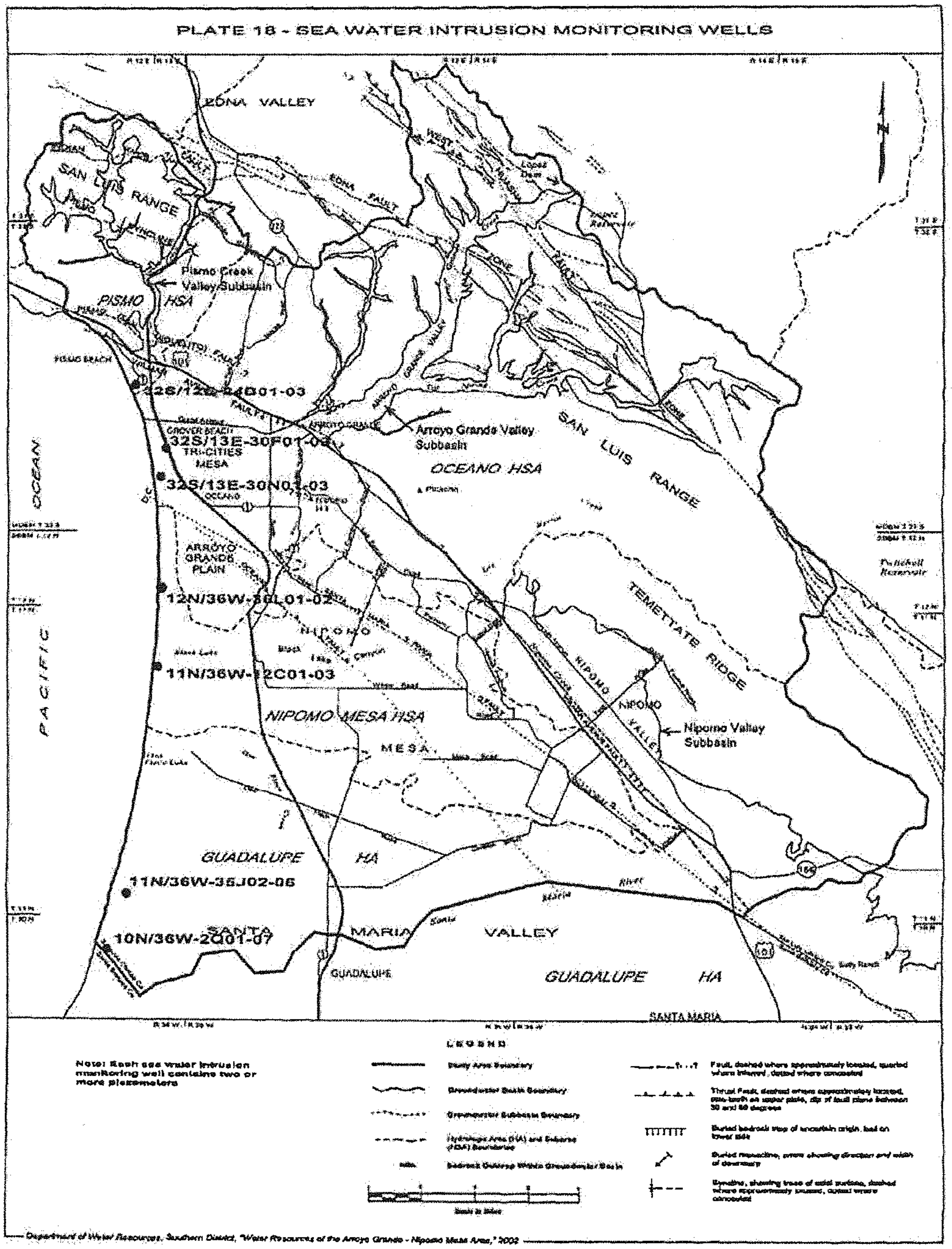
COASTAL AQUIFER CONCEPTUAL CROSS-SECTION
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 16



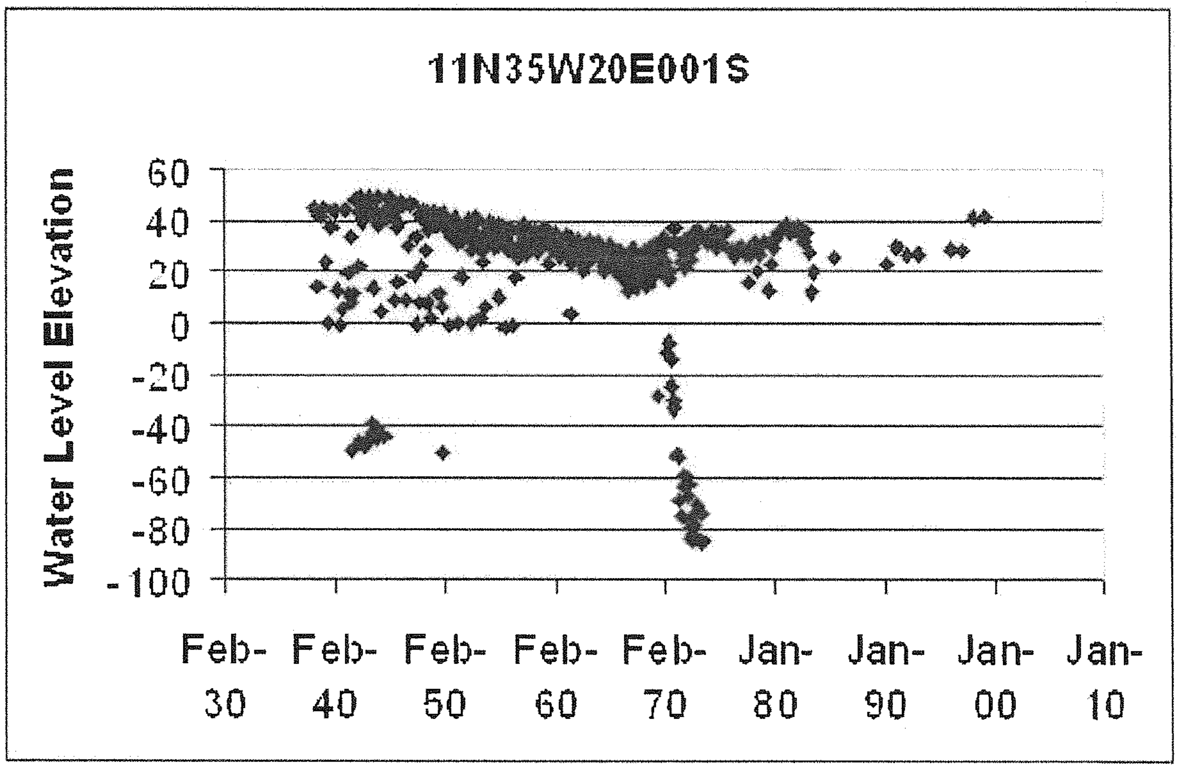
CALCULATED POSITION OF SALTWATER/FRESHWATER INTERFACE
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 17



SEA WATER INTRUSION MONITORING WELLS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 18



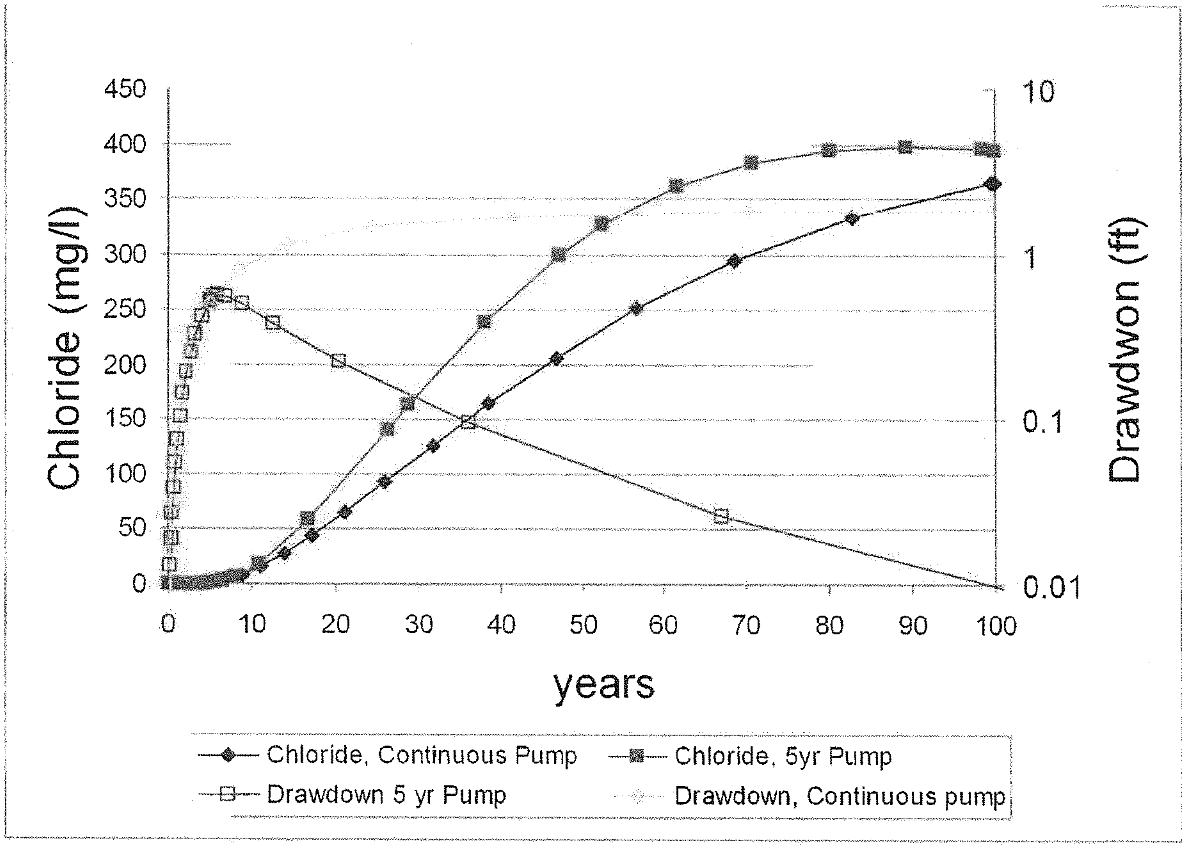
Notes:

Data from DWR online database
http://wdl.water.ca.gov/gw/admin/main_menu_gw.asp

This well is southwest of Nipomo Mesa.

HYDROGRAPH SHOWING WATER LEVELS BELOW SEA LEVEL IN WELL SOUTHWEST OF NIPOMO MESA
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 19



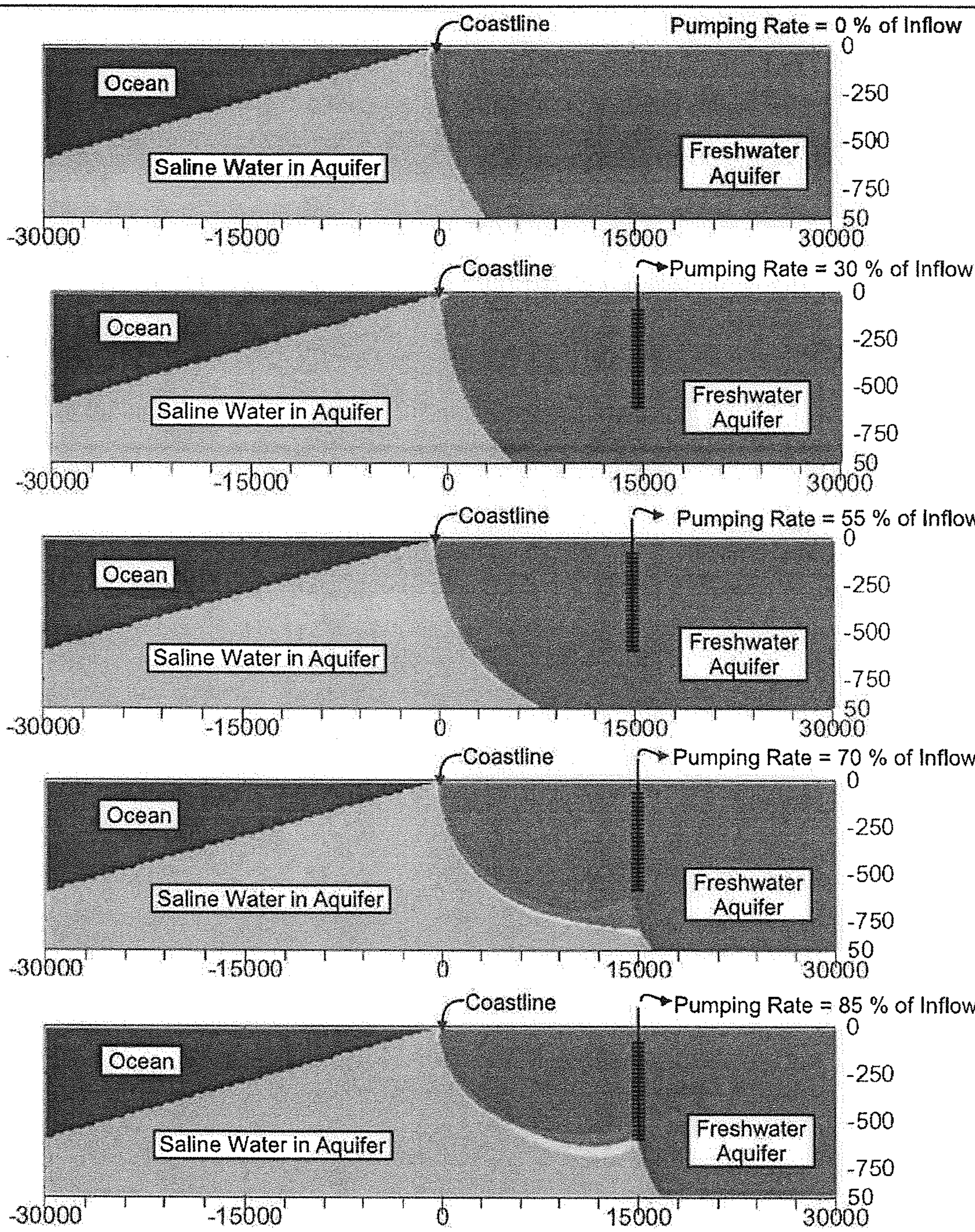
Notes:

1. Graph shows drawdown of hydraulic head in the aquifer and increase in chloride concentration for a point near the middle of the aquifer beneath the coastline.
2. Note that drawdown is logarithmic scale.
3. Pumping rate is equal to approximately 75% of groundwater discharge for non-pumping conditions.
4. Increase in chloride concentration occurs for several decades even when pumping only lasts for five years.
5. Aquifer storage coefficient 0.001

$\Sigma^2\Pi$

MODEL RESULTS SHOWING TIME LAG BENEATH COASTLINE
IN RESPONSE TO PUMPING 15,000 FEET INLAND
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 20



Notes:

Series of images depict cross-section view of a coastal margin aquifer showing equilibrium salinity distribution for a range of pumping rates. Pumping is 15000 feet inland from the coastal margin.

Model inflow includes constant head at upland margin and uniform recharge of 4 inches per year (25% of average rainfall). Summary description of the model is provided in Appendix B.

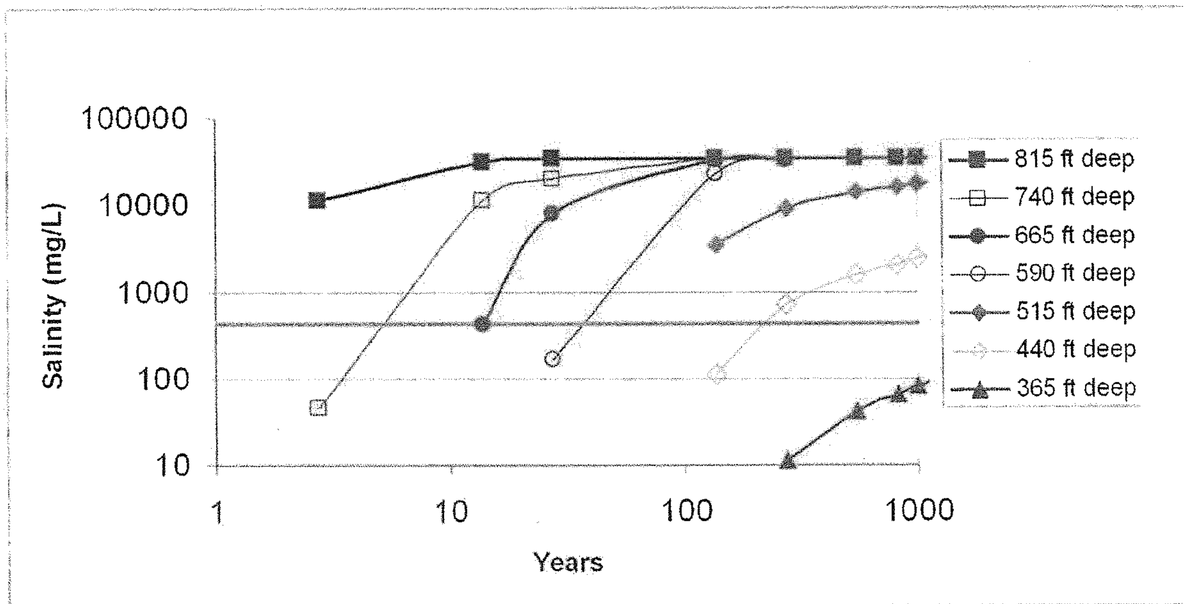
Uppermost image shows the equilibrium position of the saltwater/freshwater interface in the aquifer for the case without any pumping.

Model results suggest that saltwater intrusion becomes a likely problem when the pumping exceeds 50% of inflow.

$\Sigma^2\Pi$

MODELED SALINITY DISTRIBUTION FOR A RANGE OF PUMPING RATES
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 21



Notes:

Graph shows model increase in time of salinity in groundwater for a range of depths at distance of 3000 feet from the coastline.

Pumping well, which is 15,000 feet inland of the coastline, is screened between 100 and 600 feet bgs

Pumping rate is 70 percent of total inflow.

$\Sigma^2\Pi$

MODELED INCREASE IN SALINITY WITH TIME
3000 FEET INLAND IN RESPONSE TO PUMPING 15,000 FEET INLAND
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure 22

Appendix A

Geology of Santa Maria Basin

Nipomo Mesa Groundwater Resource Capacity Study
San Luis Obispo County, California

Appendix A: Geology of Santa Maria Basin

The Santa Maria Geologic Basin was formed by right-lateral, strike-slip faulting and concurrent deposition of marine sediments in a subsiding fault bounded block during a period of several million years in middle of the Tertiary Period of geologic time. Continued faulting, but a change in tectonic regime in middle to late Tertiary time resulted in compression of the basin, which formed large-scale folding, such as the Santa Maria syncline. Late Tertiary to relatively recent west-northwest trending reverse and thrust faults, local folding, uplift, subsidence and tilting complicates the middle Tertiary geologic framework of the basin and crustal blocks. The Santa Maria Basin extends several miles offshore where it is bounded by the Hosgri fault zone.

The Santa Maria Groundwater Basin is the upper, relatively recent and most permeable portion of the Santa Maria Geologic Basin. The aquifer system in the basin consists of unconsolidated plio-pleistocene alluvial deposits including gravel, sand, silt and clay with total thickness ranging from 200 to nearly 3,000 feet. The underlying consolidated rocks typically yield relatively insignificant quantities of water to wells. Jurassic and Cretaceous age basement complex rocks of the Franciscan and Knoxville Formations unconformably underlie the Tertiary and Quaternary rocks. A generalized geologic map of the Nipomo Area and geologic cross sections from the DWR 2002 report are provided as Figures A1 to A4.

The unconsolidated alluvial deposits in the Santa Maria Groundwater Basin include the Careaga Sand, the Paso Robles Formation, the Orcutt Formation, Quaternary Alluvium, and river channel deposits, sediment, terrace deposits and wind-blown dune sands at or near the surface.

The Careaga Sand is a late Pliocene accumulation of shallow-water marine unconsolidated to well-consolidated, coarse- to fine-grained sediments with locally common sea shell fragments and sand dollar fossils. The majority of the Careaga consists of white to yellowish-brown, loosely consolidated, massive, fossiliferous, medium- to fine-grained sand with some silt. The Careaga Sand is identified as the lowermost fresh water bearing formation in the Santa Maria Groundwater Basin, but water quality in the Careaga Sand is typically poor. It is approximately 150 feet thick under Nipomo Mesa south of the Santa Maria River Fault and thickens toward the south to approximately 700 feet beneath the Santa Maria River.

The Plio-Pleistocene Paso Robles Formation overlies the Careaga Sand and comprises the majority of the alluvial basin fill deposits. Thickness of the Paso Robles Formation is approximately 200 feet at northwestern extent of the Santa Maria basin. The Paso Robles Formation thickens to the south and reaches a maximum of approximately 2000 feet near the syclinal axis of the basin beneath the town of Orcutt south of Santa Maria. It consists of unconsolidated to poorly consolidated heterogeneous alluvium deposited under a variety of conditions including fluvial, lagoonal, and nearshore marine. The Paso Robles Formation is highly variable in color and texture, ranging from gravel and clay, sand and clay, gravel and sand, silt and clay. Most of it is fluvial in origin and in most places correlation between individual beds is not possible.

The late Pleistocene Orcutt Formation, which also is primarily fluvial in origin, locally overlies the Paso Robles Formation. In the Orcutt Upland area it is ranges in thickness from 100 to 200 feet. Based on well logs the Orcutt is report to consist of an upper fine-grained sand member and a lower coarse-grained sand and gravel member. Both members of the Orcutt become finer grained toward the coast. In most of the northern portion of the Santa Maria Groundwater Basin, the Orcutt may not be present, or has been eroded away.

Middle to late Pleistocene age alluvium, which is termed Older Alluvium by some, occurs unconformably on older rocks on the floor of Nipomo Valley. These Older Alluvium deposits are relatively minor in extent and thickness—typical thickness is 10 to 90 feet. Terrace deposits of similar age to the Older Alluvium are remnants of wave-cut platforms or older fluvial deposits, subsequently uplifted and preserved as terraces. The terrace deposits range in thickness from 1 to 15 feet and consist of reworked clasts of underlying formations. Marine terrace deposits are exposed along the coast at Pismo Beach and along the north side of Arroyo Grande Creek. The terrace deposits likely extend beneath the sand dune deposits in the Nipomo Mesa area.

Extensive deposits of Holocene Alluvium (Younger Alluvium), mainly of fluvial origin, comprise the majority of the Santa Maria Valley floor and are typically 100 to 200 feet thick. In Santa Maria Groundwater Basin, the younger alluvium overlies the Orcutt Formation if present, or the Paso Robles Formation throughout most of the northern portion of the basin. Although the 2002 DWR report treats the Holocene alluvium as single unit, sometimes it is divided into two members. The upper portion (member) becomes progressively finer-grained toward the coast with boulders gravel and sand in the Sisquoc Plain Area (upstream portion of the Santa Maria River), sand and gravel in the central and eastern Santa Maria Valley, sand with silt from SM to approximately halfway to Guadalupe, and clay with silt and minor sand westward. The lower portion (member) is mainly coarse-grained sand, gravel, cobbles and boulders with minor clay lenses near the coast. The Holocene Alluvium is approximately 130 feet thick near Hwy 101, and progressively thickens along the Santa Maria River toward the coast where it is approximately 230 feet thick.

The fine-grained facies of the upper portion of the Holocene Alluvium functions as a hydraulic confining layer above the underlying system of aquifers. Based on lithologic logs of well reports, clay beds within the Holocene alluvium range in thickness from 1 to 170 feet in the Santa Maria Plain. Cross sections in the 2002 DWR report show through-going clayey beds within the alluvium, however other reports conclude that the intervals of clay beds may not be continuous layers. In either case, it is apparent that intervals with high proportions of fine-grained material function as semi-confining units that limit the hydraulic connection between the upper portion of the Holocene Alluvium and system of aquifers below.

A mantle of late Pleistocene eolian (wind-blown) dune sands underlies the elevated area, known as Nipomo Mesa. In the 2002 DWR report these dune deposits are referred to as the Older Dunes as opposed to the Younger Dunes that are present along the coastal margin. The Holocene (older) dune deposits are reported to range in age from 40,000 to 120,000 years and were once much more extensive, but most were eroded away during the last ice age by the ancestral Arroyo Grande Creek, Los Berros Creek, and Santa Maria River. Today the Nipomo Mesa older dune sands is a triangular lobe more than 4 miles wide on the coastal side and extending inland more than 12 miles just east of Hwy 101. The dune sand consists of loosely to slightly compacted, massive but cross-bedded, coarse- to fine-grained, well-rounded quartoze sand. The older dune sands have a well-developed soil mantle and are stabilized by vegetation. Lithologic logs of water wells indicate that the Nipomo Mesa dune sands locally contain clay layers on which groundwater may be perched.

An extensive system of Holocene sand dunes occurs along a greater than 10-mile long section of the coastal margin from near just south of Pismo Beach to a couple of miles north of Point Sal.

These dunes are sometimes called the Nipomo Dunes, but are distinct from the older stabilized sand dune deposits that comprise Nipomo Mesa.

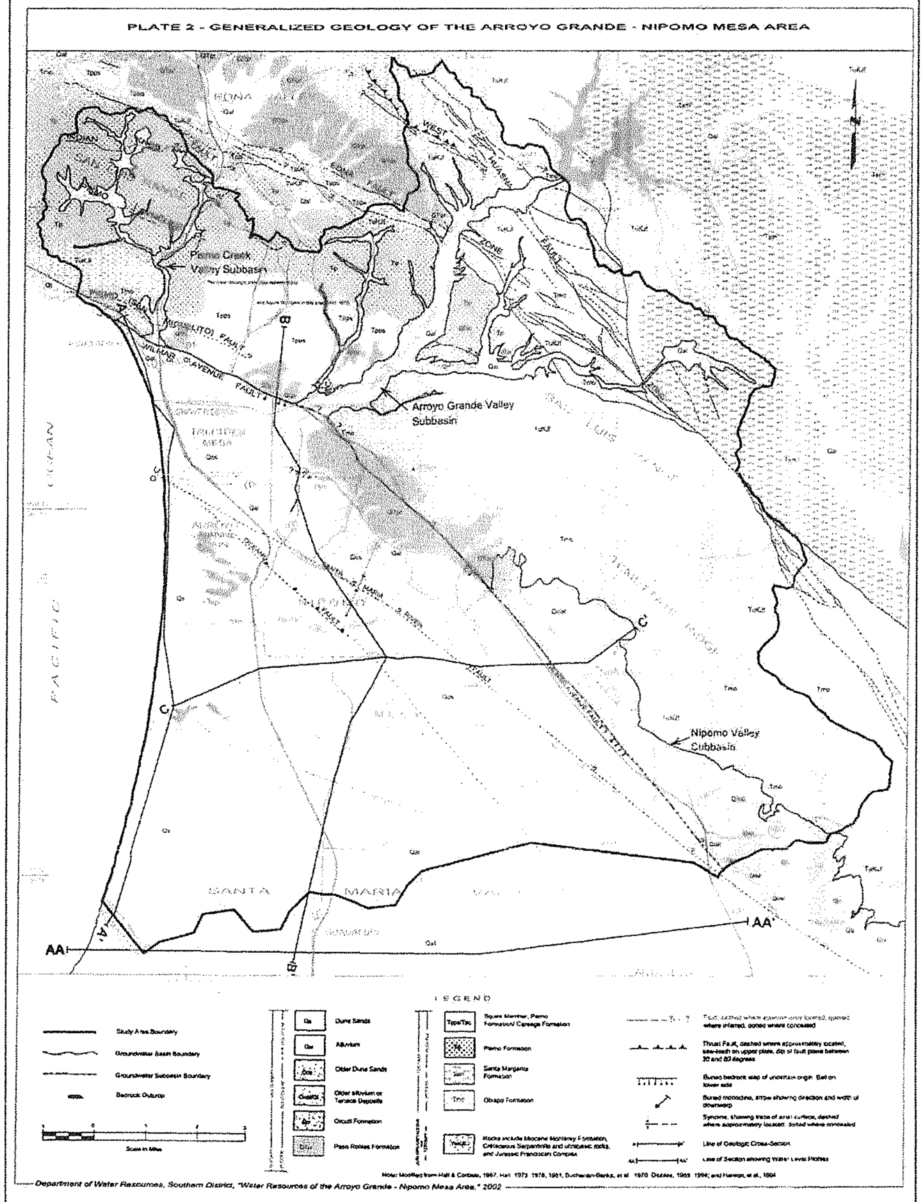
A minor alluvial deposit in Black Lake Canyon is the only alluvium in the Nipomo Mesa area.

Faults

Faults in the vicinity can be grouped into two categories: (1) largely inactive, right-lateral, strike-slip faults, and (2) potentially active reverse and thrust faults. Both groups generally trend west-northwest. Several faults are concealed within the Santa Maria Basin and the location and associated displacements are estimated from well logs and extrapolation of observations were the faults are exposed at margins of the basin or detected by offshore geophysical exploration.

The Santa Maria and Bradley Canyon Faults are both northwest-trending concealed faults that cross the Santa Maria Valley. They are reported to be high-angle reverse faults the vertically offset the Paso Robles Formation and underlying rocks, but not overlying Orcutt Formation or Quaternary Alluvium. The Santa Maria River and Oceano faults are high-angle faults beneath the northern portion of the Santa Maria basin. They extend beneath in the Nipomo Mesa area in a northwestward direction toward Oceano. Both vertically offset Paso Robles Formation and older rocks, but apparently do not displace the overlying Alluvium or Older Dune Sands. However, the Santa Maria River Fault is also reported to have a significant strike-slip component of offset. DWR reported that the Santa Maria River and Oceano Faults merge near the coastline and then merge offshore with the Hosgri Fault zone. The maximum vertical offset on the Oceano Fault is reported to be 300 to 400 feet and offset on Santa Maria River Fault, the Santa Maria Fault, and Bradley Canyon is within the range of 80 to 150 feet (L&S, 2000). Decreasing vertical offset along Oceano Fault to the southeast is believed indicate that this fault dies out near the Santa Maria River.

The DWR 2002 report discusses significant differences in water levels on opposite sides of the estimated trace of the Santa Maria River Fault, suggesting that the fault is to some degree a hydraulic barrier. However, L&S (2000) report that based on their evaluation of water level data, these faults do not appear to influence groundwater flow within the Santa Maria Groundwater Basin.



GENERALIZED GEOLOGY OF THE ARROYO GRANDE - NIPOMO MESA AREA (DWR, 2002)

SAN LUIS OBISPO, CAIFORNIA

Figure A-1

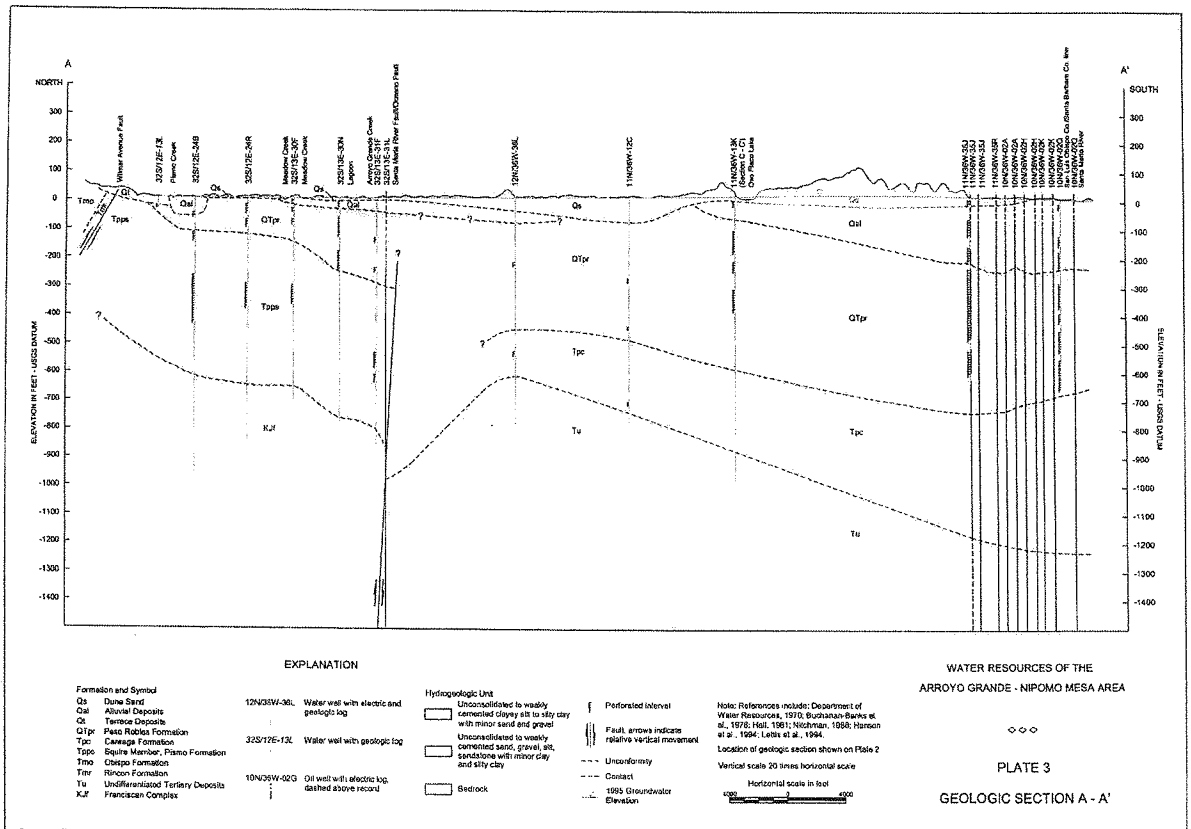
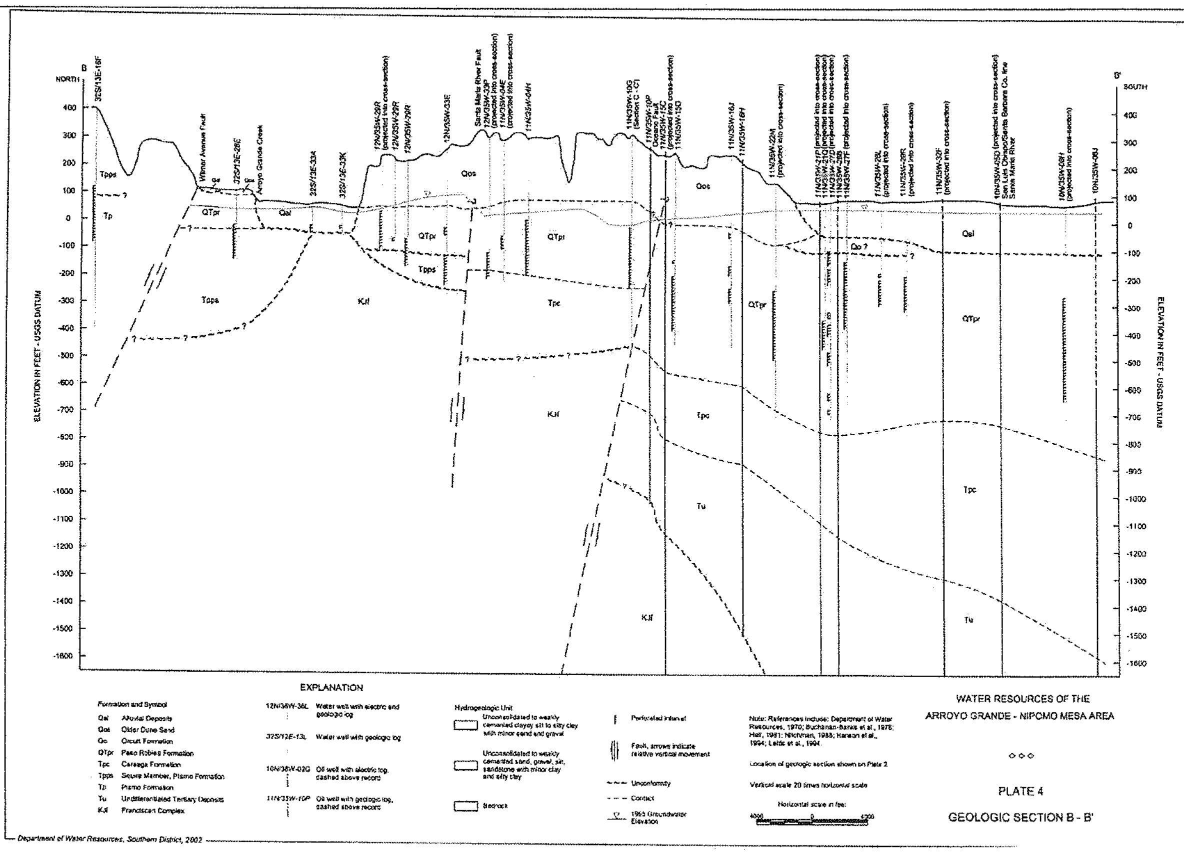

A
NORTH
A'
SOUTH
ELEVATION IN FEET - USGS DATUM
EXPLANATION
Formation and Symbol
Qs Dune Sand
Qal Alluvial Deposits
Qt Terrace Deposits
QTpr Paso Robles Formation
Tpc Careaga Formation
Tpps Squire Member, Pismo Formation
Tmo Obispo Formation
Tmr Rincon Formation
Tu Undifferentiated Tertiary Deposits
KJf Franciscan Complex
12N/36W-36L Water well with electric and geologic log
32S/12E-13L Water well with geologic log
10N/36W-02G Oil well with electric log, dashed above record
Hydrogeologic Unit
Unconsolidated to weakly cemented clayey silt to silty clay with minor sand and gravel
Unconsolidated to weakly cemented sand, gravel, silt, sandstone with minor clay and silty clay
Bedrock
Perforated interval
Fault, arrows indicate relative vertical movement
Unconformity
Contact
1995 Groundwater Elevation
Note: References include: Department of Water Resources, 1970; Buchanan-Banks et al., 1978; Hall, 1981; Nitchman, 1988; Hanson et al., 1994; Lettis et al., 1994.
Location of geologic section shown on Plate 2
Vertical scale 20 times horizontal scale
Horizontal scale in feet
WATER RESOURCES OF THE
ARROYO GRANDE - NIPOMO MESA AREA
PLATE 3
GEOLOGIC SECTION A - A'
Department of Water Resources, Southern District, 2002

Figure A-2



B
NORTH
B'
SOUTH
ELEVATION IN FEET - USGS DATUM
EXPLANATION
Formation and Symbol
Qal Alluvial Deposits
Qos Older Dune Sand
Qo Orcutt Formation
QTpr Paso Robles Formation
Tpc Careaga Formation
Tpps Squire Member, Pismo Formation
Tp Pismo Formation
Tu Undifferentiated Tertiary Deposits
KJf Franciscan Complex
Water well with electric and geologic log
Water well with geologic log
Oil well with electric log, dashed above record
Oil well with geologic log, dashed above record
Hydrogeologic Unit
Unconsolidated to weakly cemented clayey silt to silty clay with minor sand and gravel
Unconsolidated to weakly cemented sand, gravel, silt, sandstone with minor clay and silty clay
Bedrock
Perforated interval
Fault, arrows indicate relative vertical movement
Unconformity
Contact
1965 Groundwater Elevation
Location of geologic section shown on Plate 2
Vertical scale 20 times horizontal scale
Horizontal scale in feet
WATER RESOURCES OF THE
ARROYO GRANDE - NIPOMO MESA AREA
PLATE 4
GEOLOGIC SECTION B - B'
Department of Water Resources, Southern District, 2002

Figure A-3

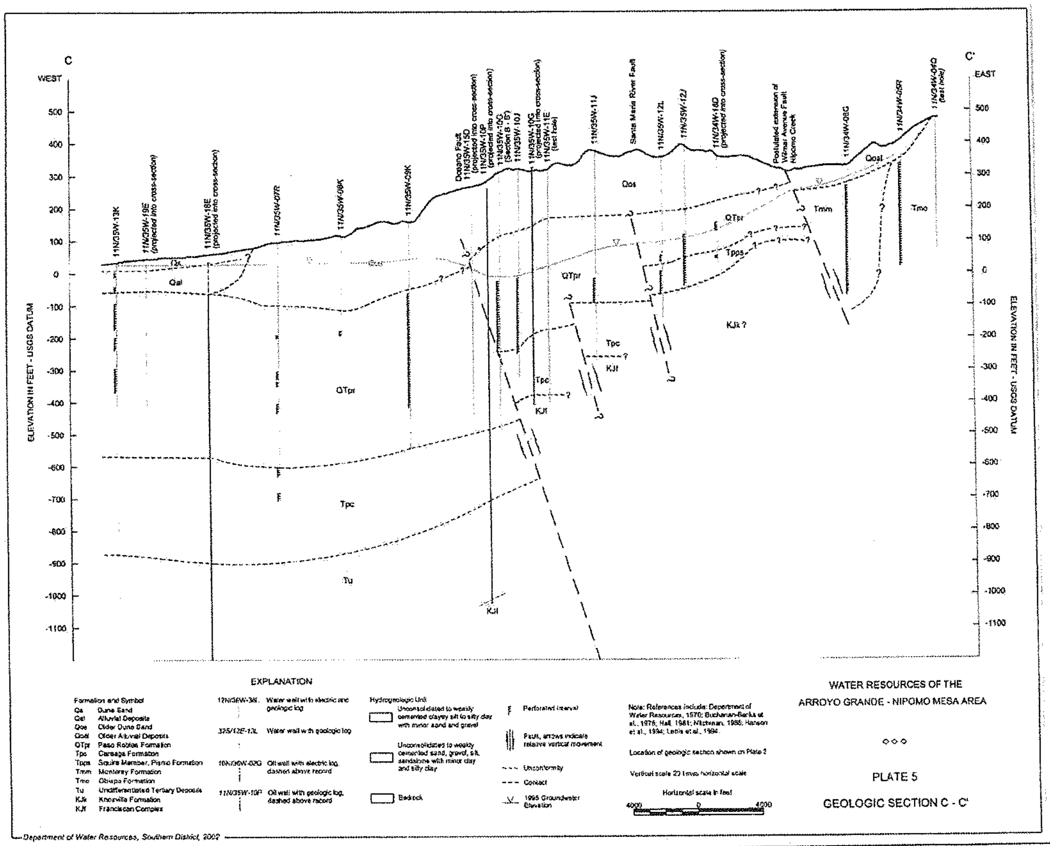

C
C'
WEST
EAST
ELEVATION IN FEET - USGS DATUM
EXPLANATION
Formation and Symbol
Qs Dune Sand
Qal Alluvial Deposits
Qos Older Dune Sand
Qoal Older Alluvial Deposits
QTpr Paso Robles Formation
Tpc Careaga Formation
Tpps Squire Member, Pismo Formation
Tmm Monterey Formation
Tmo Obispo Formation
Tu Undifferentiated Tertiary Deposits
KJk Knoxville Formation
KJf Franciscan Complex
Water well with electric and geologic log
Water well with geologic log
Oil well with electric log, dashed above record
Oil well with geologic log, dashed above record
Hydrogeologic Unit
Unconsolidated to weakly cemented clayey silt to silty clay with minor sand and gravel
Unconsolidated to weakly cemented sand, gravel, silt, sandstone with minor clay and silty clay
Bedrock
Perforated interval
Fault, arrows indicate relative vertical movement
Unconformity
Contact
1995 Groundwater Elevation
Location of geologic section shown on Plate 2
Vertical scale 20 times horizontal scale
Horizontal scale in feet
WATER RESOURCES OF THE
ARROYO GRANDE - NIPOMO MESA AREA
PLATE 5
GEOLOGIC SECTION C - C'
Department of Water Resources, Southern District, 2002

Figure A-4

Appendix B

Recharge Rate is Not Equivalent to Safe Yield

Nipomo Mesa Groundwater Resource Capacity Study
San Luis Obispo County, California

Collection of References:

Sophocleous, M., 1997, Managing water resources systems: why "safe yield" is not sustainable: Ground Water, v. 35, no. 4, p. 561.

Bredehoeft, J., 1997, Safe yield and the water budget myth: Ground Water, v. 35, no. 6, p. 929.

Bredehoeft, J., 2002, The Water Budget Myth Revisited: Why Hydrogeologists Model: Ground Water, v. 40, no. 4, p. 340-345.

EDITORIAL

MANAGING WATER RESOURCES SYSTEMS: WHY "SAFE YIELD" IS NOT SUSTAINABLE

by Marios Sophocleous[a]

Although major gaps in our understanding of soil and water ecosystems still exist, of more importance are the gaps between what is known and what is applied. One such gap is in the use of the concept of "safe yield" (SY) in ground-water management. Despite being repeatedly discredited in the literature, SY continues to be used as the basis of state and local water-management policies, leading to continued ground-water depletion, stream dewatering, and loss of wetland and riparian ecosystems.

Traditionally, "safe yield" has been defined as the attainment and maintenance of a long-term balance between the amount of ground water withdrawn annually and the annual amount of recharge. Thus, SY limits ground-water pumping to the amount that is replenished naturally. Unfortunately, this concept of SY ignores discharge from the system. Under natural or equilibrium conditions, recharge is balanced, in the long term, by discharge from the aquifer into a stream, spring, or seep. Consequently, if pumping equals recharge, eventually streams, marshes, and springs dry up. Continued pumping in excess of recharge also eventually depletes the aquifer. This has happened in various locations across the Great Plains. Maps comparing the perennial streams in Kansas in the 1960s to those of the 1990s show a marked decrease in miles of streamflow in the western third of the state. (For more information on SY, see the edited volume by Sophocleous, 1997, "Perspectives on Sustainable Development of Water Resources in Kansas," Kansas Geological Survey, Bulletin 239, in press.) Policymakers are primarily concerned about aquifer drawdown and surface-water depletion, both unrelated to the natural recharge rate. Despite its irrelevance, natural recharge is often used in ground-water policy to balance ground-water use under the banner of SY. Adopting such an attractive fallacy does not provide scientific credibility.

To better understand why "safe yield" is not sustainable yield, a review of hydrologic principles (concisely stated by Theis in 1940) is required. Under natural conditions, prior to development by wells, aquifers are in a state of approximate dynamic equilibrium: over hundreds of years, recharge equals discharge. Discharge from wells upsets this equilibrium by producing a loss from aquifer storage. A new state of dynamic equilibrium is reached only by an increase in recharge (induced recharge), a decrease in natural discharge, or a combination of the two. Initially, ground water pumped from the aquifer comes from storage, but ultimately it comes from induced recharge. The timing of this transition, which takes a long time by human standards, is a key factor in developing sustainable water-use policies. However, it is exceedingly difficult to distinguish between natural recharge and induced recharge to ascertain possible sustained yield. This is an area that needs further research. Calibrated stream-aquifer models could provide some answers in this regard.

The concept of sustainable yield has been around for many years, but a quantitative methodology for the estimation of such yield has not yet been perfected. A suitable hydrologic basis for determining the magnitude of possible development would be a quantification of the transition curve (from ground-water storage depletion to full reliance on induced recharge), coupled with a projected pattern of drawdown for the system under consideration. The level of ground-water development would be calculated using specified withdrawal rates, well-field locations, drawdown limits, and a defined planning horizon. Stream-aquifer models are capable of generating the transition curve for most situations.

Another problem with SY is that it has often been used as a single-product exploitation goal—the number of trees that can be cut, the number of fish that can be caught, the volume of water that can be pumped from the ground or river, year after year, without destroying the resource base. But experience has repeatedly shown that other resources inevitably depend on the exploited product. We can maximize our SY of water by drying up our streams, but when we do, we learn that the streams were more than just containers of usable water.

A better definition of SY would address the sustainability of the system—not just the trees, but the whole forest; not just the fish, but the marine food chain; not just the ground water, but the running streams, wetlands, and all the plants and animals that depend on it. Given the dynamic connectedness of a watershed, management activities can fragment the habitat "patches" if they are not planned and implemented from an ecosystem and watershed perspective. Such a holistic approach, however, is fraught with difficulty. We cannot use a natural system without altering it, and the more intensive and efficient the use, the greater the alteration.

Science will never know all there is to know. Rather than allowing the unknown or uncertain to paralyze us, we must apply the best of what we know today, and, at the same time, be flexible enough to allow for change and for what we do not yet know. Instead of determining a fixed sustainable yield, managers should recognize that yield varies over time as environmental conditions vary.

Our understanding of the basic principles of soil and water systems is fairly good, but our ability to use this knowledge to solve problems in complex local and cultural settings is relatively weak. Communication is vital. We need people who can transfer research findings to the field and who can also communicate water-users' needs to the researchers. Delivering a journal publication to a manager's desk is not sufficient to ensure that research results are quickly put into practice. I believe this breakdown in communication accounts for the persistence of such misguided concepts as SY in ground-water management today. Researchers increasingly must cross the boundaries of their individual disciplines, and they must look to their clients—the managers and water users—for help in defining a practical context for research. A strong public education program is also needed to improve understanding of the nature and complexity of ground-water resources and to emphasize how this understanding must form the basis for operating conditions and constraints. This is the only way to positively influence, for the long term, the attitudes of the various stakeholders involved.

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GROUND WATER

Editorial

Safe Yield and the Water Budget Myth

by John Bredehoeft[a]

The editorial by Marios Sophocleous in the July-August issue of *Ground Water* is an especially important one. I agree with Marios, the idea of safe yield as it is generally expressed in which the size of a development if it is less than or equal to the recharge is considered to be "safe" is fallacious. As Marios indicates, Theis pointed out the fallacy of this notion of "safe yield" in a 1940 paper entitled: *The source of water to wells: essential factors controlling the response of an aquifer to development (Civil Engineering*, p. 277–280)—every practitioner of ground water should go back and read this paper. Theis' 1940 principle is one of the least understood concepts in ground-water hydrology.

Hilton Cooper, Stavros Papodopulos, and I reiterated Theis' paradigm in a 1982 paper entitled: *The water-budget myth (Scientific Basis of Water Management, National Academy of Sciences Studies in Geophysics*, p. 51–57). At the time, Theis said to me that this paper eliminated the need for a paper he had been contemplating. Unfortunately, our 1982 paper was printed in an obscure publication; and yet it may be one of the more important papers we wrote.

I have some additional remarks to add to Marios Sophocleous' editorial. As Marios correctly indicated, Theis stated: "*A new state of dynamic equilibrium is reached only by an increase in recharge (induced recharge), a decrease in discharge, or a combination of the two.*" Cooper, Theis, and others had a name for the sum of increased recharge plus the decreased discharge—they refer to it as capture. In order for a development to reach a new equilibrium, the capture must ultimately equal the new stress on the system, the development. Capture is dynamic, and depends upon both the aquifer geometry and the parameters (permeability and specific storage) of the system. This is why both well response and aquifer system response are so much a part of ground-water hydrology.

In my experience, the recharge, and certainly the change in recharge due to a development (induced recharge) is difficult, if not impossible, to quantify. Usually the recharge is fixed by rainfall and does not change with development. Marios leaves an impression that the change in recharge (induced recharge) is where our focus as ground-water hydrologists should be. It is on this point that we may differ.

Commonly the virgin discharge is what changes and makes it possible to bring a ground water system into balance. Capture is a dynamic quantity that changes through time until the system reaches a new equilibrium. Usually this is what we attempt to quantify with flow models—we estimate the magnitude of the capture from the virgin (natural) discharge. It is usually much more important to focus on the discharge, and the change in discharge—the capture. Capture from the natural discharge is usually what determines the size of a sustainable development.

Pumping does not have to exceed the recharge for streams to be depleted. Pumping is an additional stress on the system. The water pumped will usually be supplied from both storage and from reduced natural discharge. We define equilibrium as a state in which there is no more change in ground-water storage with time—water levels are stable in time. If no new equilibrium can be reached, as Theis showed for the high plains aquifer of New Mexico, the aquifer will continue to be depleted. Once a new equilibrium is reached, the natural discharge is reduced by an amount equal to the development—capture equals development. This statement has nothing to do with recharge. Often streams are depleted long before the pumping reaches the magnitude of the recharge.

It is important that the profession understand the concept of safe yield. Sustainable ground-water developments have almost nothing to do with recharge; as Marios correctly states, it is irrelevant. However, I continue to hear my colleagues say they are studying the recharge in order to size a development—I heard this again last week. The water budget as it is usually applied to scale development is a myth—Theis said this in 1940. Yet the profession continues to perpetuate this wrong paradigm.

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The views expressed here are the author's and not necessarily those of the AGWSE, NGWA, and/or the Ground Water Publishing Company.

ground water

Issue Paper/

The Water Budget Myth Revisited: Why Hydrogeologists Model

by John D. Bredehoeft[1]

Abstract/

Within the ground water community, the idea persists that if one can estimate the recharge to a ground water system, one then can determine the size of a sustainable development. Theis addressed this idea in 1940 and showed it to be wrong—yet the myth continues. The size of a sustainable ground water development usually depends on how much of the discharge from the system can be "captured" by the development. Capture is independent of the recharge; it depends on the dynamic response of the aquifer system to the development. Ground water models were created to study the response dynamics of ground water systems; it is one of the principal reasons hydrogeologists model.

Introduction

The idea persists within the ground water community that if one can determine the recharge to an aquifer system then one can determine the maximum magnitude of a sustainable development. One commonly hears the statement, "the pumping must not exceed the recharge (if the development is to be sustainable)."

The idea that the recharge (by which one usually means the virgin recharge before development) is important in determining the magnitude of sustainable development is a myth. A number of hydrogeologists have tried to debunk the myth, starting with Theis (1940) in a paper titled "The Source of Water Derived from Wells: Essential Factors Controlling the Response of an Aquifer to Development." Brown (1963) and Bredehoeft et al. (1982) wrote papers debunking the myth. Unfortunately, the message in Brown's paper was apparent only to those deeply schooled in ground water hydrology. The Bredehoeft et al. paper, while more readily understandable, was published in an obscure National Academy of Science publication that is out of print. At the time the Bredehoeft et al. paper was published, Theis congratulated the authors, commenting that he had intended to write another paper on the subject, but now he did not see the need. Needless to say, in spite of these efforts the myth goes on; it is so ingrained in the community's collective thinking that nothing seems to derail it.

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It is presumptuous and perhaps arrogant of me to imply that the entire community of ground water hydrologists does not understand the principles first set forth by Theis in 1940; clearly this is not the situation. There are good discussions in recent papers that indicate other hydrogeologists understand Theis' message. The 1999 USGS Circular 1186, *Sustainability of Ground-Water Resources* (Alley et al. 1999), states the ideas lucidly. Sophocleous and his colleagues at the Kansas Geological Survey have published extensively on the concept of ground water sustainability; Sophocleous (2000) presents a summary of his ideas that contain the essence of Theis' principles.

On the other hand, I do not find Theis' principles on sustainabilty expressed clearly in the texts on ground water. These ideas were taught to me, early in my career, by my mentors at the U.S. Geological Survey. Also I find in discussions with other ground water professionals that these ideas, even though they are 60 years old, are not clearly understood by many individuals. It is my purpose in this paper to address again the myth that recharge is all important in determining the size of a sustainable ground water development, and show that this idea has no basis in fact.

Analytical Methods in Hydrogeology

Before digital computer modeling codes, hydrogeologists used traditional analytical methods to assess the impacts of wells on ground water systems. The traditional method of analysis used is the principle of superposition. In this approach, one assumes that the hydraulic head (or the water table) before development resulted from the inputs and outputs (recharge and discharge) from the system. One analyzes the impact of pumping independent of the initial (virgin) hydraulic head. The cone of depression is calculated as a function of time. This cone of depression is then superposed upon the existing hydraulic head (or water table). The resulting head after superposition is the solution to the development.

To make such a superposition calculation, one needs: (1) the transmissivity and storativity distribution within the aquifer, (2) the boundary conditions that will be reached by the cone of depression, and (3) the rate of pumping. Those trained in classical hydraulic theory are well aware of reflection boundaries and image wells to account for the boundary conditions.

Missing from the classical analysis is any mention of recharge. The recharge is taken into account by the initial hydraulic head (or the water table). The initial head is a solution to an initial boundary value problem that includes the recharge and discharge.

Prior to the widespread use of digital computer models most analyses in ground water flow were made using the principles of superposition. This was also the methodology used in the analog computer models of the 1950s, '60s, and '70s. With the advent of digital computer models, it became feasible to specify the varying distributions of recharge and discharge with the idea of solving for the virgin water table. The calculated water table can then be compared to the observed water table (or hydraulic head). To do such an analysis requires knowledge of the distribution of both the virgin rate of recharge and the virgin rate of discharge—in addition to the transmissivity distribution and the boundary conditions.

With an estimate of the rainfall, there is still no idea of how large the recharge is, except that it cannot exceed some unknown fraction of rainfall. The researcher may know the transmissivity of the aquifer at a few places and the aquifer discharge that makes up the baseflow of streams associated with the aquifer. Based on this set of limited information, a steady-state model analysis is made in an attempt to estimate the transmissivity of the aquifer. This is a common model analysis. In this context, knowledge of the virgin recharge is useful in estimating the transmissivity.

The recharge and the discharge are the inputs and outputs from a ground water system. Both quantities are important in understanding how a particular ground water system functions. However, it is not my purpose in this paper to discuss recharge or discharge. My focus is on how recharge and discharge enter into the determination of the sustainable yield of a ground water system.

In the classical analytical method, the important variables for determining the impacts of pumping are those that describe the dynamic response of the system—the distribution of aquifer diffusivity and the boundary conditions. This argument was the thrust of Brown's 1963 paper. The argument makes sense to one trained in classical analytical methods; it is more obscure to others. Brown's paper made almost no impact. I will attempt to further simplify the mathematical argument.

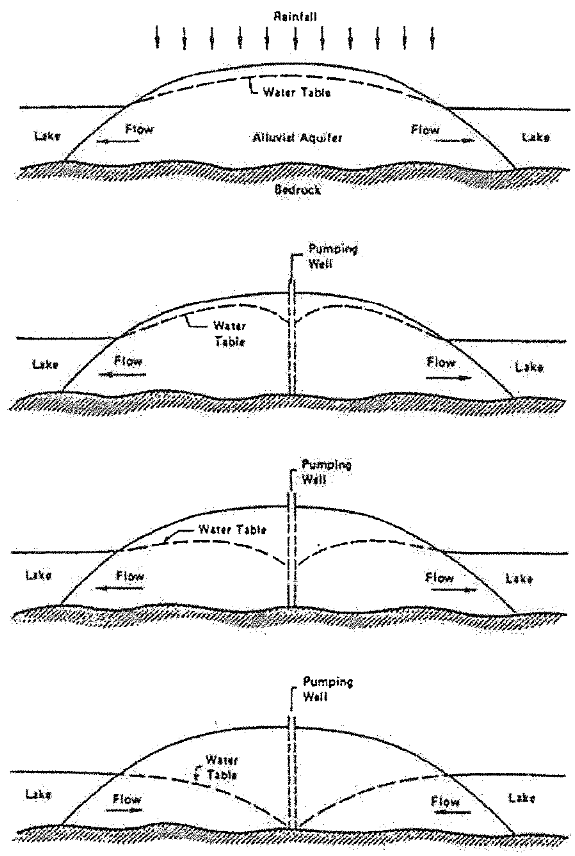

Figure 1. Schematic cross section of an aquifer situated on a circular island in a fresh water lake that is being developed by pumping. (Reprinted with permission from *Scientific Basis of Water-Resource Management*. Copyright 1982 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.)

The Water Budget

To illustrate the basic premise, I want to consider a simple aquifer system. A permeable alluvial aquifer underlies a circular island in a fresh water lake. Our intent is to develop a well on the island. The island aquifer is shown schematically in various stages of development in Figure 1.

Before development, recharge from rainfall creates a water table. The recharge over the island is balanced by discharge from the permeable aquifer directly to the lake (Figure 1—top cross section). We can write the following water balance for virgin conditions on our island:

$$R_0 = D_0 \qquad \text{or} \qquad R_0 - D_0 = 0$$

where R_0 is the virgin recharge (this is the recharge generally referred to in the myth), and D_0 is the virgin discharge. A water table develops on the island in response to the distribution of recharge and discharge and the transmissivity of the alluvial aquifer (Figure 1—top cross section).

The discharge to the lake can be obtained at any point along the shore by applying Darcy's law:

$$d = T\,(dh/dl)$$

where d is the discharge through the aquifer at any point along the shore; T is the transmissivity at the same point; and dh/dl is the gradient in the water table at that point. If we integrate the point discharge along the entire shoreline of the island we obtain the total discharge from the island:

$$\int T\,(dh/dl)\,ds = D_0$$

We now go into the middle of the island, install a well and initiate pumping (Figure 1—second cross section). At any new time, we can write a new water balance for the island:

$$(R_0 + \Delta R_0) - (D_0 + \Delta D_0) - P + dV/dt = 0$$

where ΔR_0 is the change in the virgin rate of recharge caused by our pumping; ΔD_0 is the change in the virgin rate of discharge caused by the pumping; P is the rate of pumping; and dV/dt is the rate at which we are removing water from ground water storage on the island.

We know that the virgin rate of recharge, R_0, is equal to the virgin rate of discharge, D_0, so our water budget equation following the initiation of pumping reduces to

$$\Delta R_0 - \Delta D_0 - P + dV/dt = 0$$

or

$$\Delta R_0 - \Delta D_0 - P = dV/dt$$

For a sustainable development, we want the rate of water taken from storage to be zero; in other words, we define sustainability as

$$dV/dt = 0$$

Now our water budget for sustainable development is

$$\Delta R_0 - \Delta D_0 = P$$

We are now stating that, to reach a sustainable development, the pumping must be balanced by a change in the virgin rate of recharge, ΔR_0, and/or a change in the virgin rate of discharge, ΔD_0, caused by the pumping. Traditionally, the sum of the change in recharge and the change in discharge caused by the pumping, the quantity $(\Delta R_0 - \Delta D_0)$, is defined as the "capture" attributable to the pumping. To be a sustainable development, the rate of pumping must equal the rate of capture.

Notice that to determine sustainability we do not need to know the recharge. The recharge may be of interest, as are all the facets of the hydrologic budget, but it is not a determining factor in our analysis.

Recharge is often a function of external conditions—such as rainfall, vegetation, and soil permeability. In many, if not most, ground water situations, the rate of recharge cannot be impacted by the pumping; in other words, in terms of our water budget,

$$\Delta R_0 = 0$$

In most situations, sustainability of a ground water development occurs when the pumping captures an equal amount of virgin discharge:

$$P = \Delta D_0$$

Let's return to the island aquifer and see how the capture occurs conceptually. When we start to pump, a cone of depression is created. Figure 1 (second cross section) shows the cone of depression at an early stage in the development of our island aquifer. The natural discharge from the island does not start to change until the cone of depression changes the slope in the water table at the shore of the island; remember: Darcy's law controls the discharge at the shoreline. Until the slope of the water table at the shoreline is changed by the pumping, the natural discharge continues at its virgin rate. Until the point in time that the cone reaches the shore and changes the water table gradient significantly, all water pumped from the well is supplied totally from storage in the aquifer. In other words, the cone of depression must reach the shoreline before the natural discharge is impacted (Figure 1—third cross section). The rate at which the cone of depression develops, reaches the shoreline, and then changes the slope of the water table there depends on the dynamics of the aquifer system—transmissivity, storativity (or specific yield), and boundary conditions. The rate of capture in a ground water system is a problem in the dynamics of the system. Capture has nothing to do with the virgin rate of recharge; the recharge is irrelevant in determining the rate of capture.

Figure 1 (third cross section) shows the water table in our island aquifer at a point in time when the natural discharge is almost eliminated; the slope of the water table is almost flat at the shoreline. I deliberately created an aquifer system in which one can induce water to flow from the lake into the aquifer (Figure 1—fourth cross section). In this instance, the sustainable development can exceed the virgin recharge (or the virgin discharge). This again suggests that the recharge is not a relevant input in determining the magnitude of a sustainable development.

Often the geometry of the aquifer restricts the capture. For example, were the aquifer on the island to be thin, we might run out of water at the pump long before we could capture any fraction of the discharge. In this case all water pumped would come from storage. It would be "mined." In the island example, with a thin aquifer, the well could run dry before it could impact the discharge at the shoreline. Notice in Figure 1 (fourth cross section) that I have drawn the situation where the drawdown reached the bottom of the aquifer; the aquifer geometry and diffusivity limit the potential drawdown at the well. This again points out that the dynamic response of the aquifer system is all-important to determining the impacts of development. It is for these reasons that hydrogeologists are concerned with the dynamics of aquifer system response. Hydrogeologists model aquifers in an attempt to understand their dynamics.

Clearly, the circular island aquifer is a simple system. Even so, the principles explained in terms of this simple aquifer apply to all ground water systems. It is the dynamics of how capture takes place in an aquifer that ultimately determines how large a sustainable ground water development can be.

Water Law in the West

Nevada recognized in the early 1900s that the water supply for many of the valleys within the state would have to come totally from local ground water. Enlightened individuals in Nevada decided to attempt to make the ground water supply within these valleys sustainable. The total discharge in many of the closed valleys in Nevada is by evaporation from the playas and from the transpiration (evapotranspiration [ET]) of phreatophytic plants that tap the water table. Nevada was willing to let the ground water pumping capture both the evaporation of ground water and the ground water that went to support the phreatophytic plants. This thinking led to the Nevada Doctrine that ground water pumping must not exceed the recharge. Perhaps the Nevada Doctrine perpetuates the myth. In reality the Nevada Doctrine is a roundabout statement that the development must not exceed the potential capture of ET (because as shown previously, the virgin ET is equal to the virgin rate of recharge).

As an aside, it has been difficult for the state engineer in Nevada to administer this doctrine in places of heavy urbanization such as Las Vegas, even though Nevada law codified the doctrine. The law also has been difficult to administer where discharge from a valley occurs as perennial streamflow (surface water) that is already appropriated.

The case of the perennial stream with an associated aquifer raises the problem of stream depletion, where pumping impacts streamflow that is appropriated by downstream users. Again, stream depletion is a dynamic ground water problem in capture—all the principles of the simple island example apply. Western water law recognizes the process of stream depletion with varying degrees of success—from zero to full recognition, depending upon the particular state.

Aquifer Dynamics and Models

Since the development of the Theis equation in 1935, hydrogeologists have been concerned with the dynamics of aquifer response to stress: pumping or recharge. Once Theis (1935) and later Jacob (1940) showed the analogy of ground water flow to heat flow, the ground water community has been busy solving the appropriate boundary value problems that describe various schemes of development. This endeavor has gone through several stages.

The 1940s and 1950s were a time during which the ground water profession was concerned with solving the problems of flow to a single well. Numerous solutions to the single well problem were produced. These solutions were used both to predict the response of the aquifer system and to estimate aquifer properties—transmissivity (or permeability) and storativity.

Hydrogeologists of that day saw the limitations in analyzing wells and sought a more robust methodology by which to analyze an entire aquifer, including complex boundary conditions and aquifer heterogeneity. The search led a group at the U.S. Geological Survey (USGS) to invent the analog model in the 1950s; the genius behind this development was Herb Skibitski, one of those individuals who rarely published. The new tool was the electric analog computer model of the aquifer. The model consisted of a finite-difference network of resistors and capacitors. In the analog computer, aquifer transmissivity is represented by the network of resistors; the storativity is represented by the network of capacitors. The resulting resistor-capacitor network is excited by electrical function generators that simulate pumping or other stresses. Voltage is equivalent to hydraulic head in the analog computer; electrical current is equivalent to the flow of water.

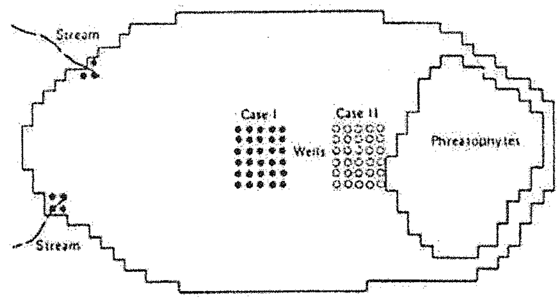

Figure 2. **Plan view of a hypothetical closed basin aquifer that is being developed.** (Reprinted with permission from *Scientific Basis of Water-Resource Management.* Copyright 1982 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.)

In reality, these were elegant finite-difference computer models of aquifer systems. By 1960, the USGS had a facility in Phoenix, Arizona, where analog models of aquifers were routinely built on a production basis. Some of these analog models had multiple aquifers; some had as many as 250,000 nodes. At the time, it was infeasible to solve the same problems with digital computers; the digital computers of the day were too small and too slow. However, by 1970 the power of digital computers increased to the point that digital aquifer models could begin to compete with the analog models. By 1980 digital computer models had replaced the analog models, even at the USGS. The models of the 1980s have now grown to include solute transport, pre- and postprocessors, and automatic parameter estimation. By far the vast majority of ground water flow problems are simulated using the USGS code MODFOW; there is a new version MODFLOW 2000.

The ground water model is a tool with which to investigate the dynamics of realistic aquifer systems. As suggested previously, it is only through the study and understanding of aquifer dynamics that one can determine the impact of an imposed stress on an aquifer system.

Dynamics of a Basin and Range Aquifer

To illustrate the dynamic response of aquifers, I will use closed basin aquifers such as those in the Basin and Range of Nevada as the prototypes. The aquifer geometry is illustrated in plan view in Figure 2. The basin is approximately 50 miles in length by 25 miles in width. At the upper end of the valley, two streams emerge from the nearby mountains and recharge the aquifer at an average combined rate of 100 cfs; approximately 70,000 acre-feet annually. At the lower end of the valley, an area of phreatophyte vegetation discharges ground water as ET at an average rate of 100 cfs. The system before development is in balance; 100 cfs is being recharged, and 100 cfs is being discharged by ET.

Table 1
Aquifer Properties for Our Hypothetical Basin and Range Aquifers

Basin size	50 × 25 miles (Figure 2)
Cell dimensions	1 × 1 mile
Hydraulic conductivity	0.0005 and 0.00025 ft/sec
Saturated thickness transmissivity	2000 ft 1.0 and 0.5 ft^2/sec (approximately 90,000 and 40,000 ft^2/day—both highly transmissive)
Storage coefficient	0.1%–10% specific yield
Phreatophyte area	170 mi^2
Average consumption	100 cfs
Wellfield area	30 mi^2
Average pumping	100 cfs
Recharge	100 cfs

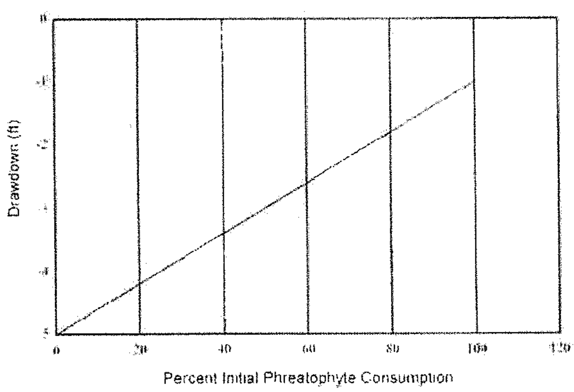

Figure 3. Linear function relating phreatophyte use to drawdown in the aquifer.

To simulate a well development in this aquifer, I will make the size of the development equal to the recharge (and the discharge) 100 cfs. We consider two locations for our wellfield, shown as Case I and Case II in Figure 2. The Case II wellfield is closer to the area of phreatophyte vegetation. To simulate the system, we need aquifer properties; the aquifer properties are specified in Table 1.

In our hypothetical system, we will eliminate phreatophyte ground water consumption as the pumping lowers the water table in the area containing phreatopyhtes. I deliberately created a ground water system in which capture of ET can occur. A linear function is used to cut off the phreatophyte consumption. As the water table drops from 1 to 5 feet, we linearly reduce the phreatophyte use of ground water—the function is shown in Figure 3. The reduction in phreatophyte use does not start until the ground water declines 1 foot; by the time the water table drops 5 feet, the phreatophyte use is eliminated in that cell. The phreatophyte reduction function is applied cell by cell in the model.

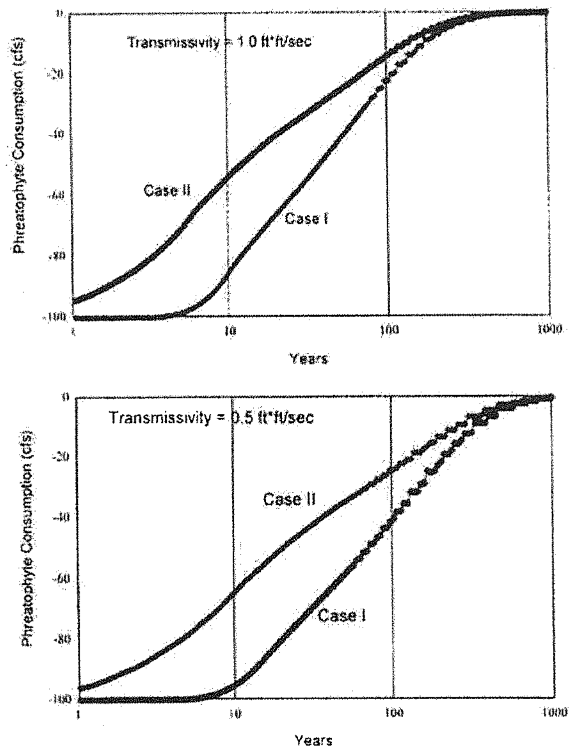

Figure 4. Plots of phreatophyte use vs. time.

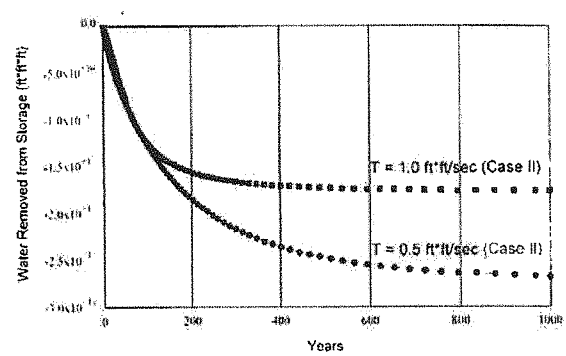

Figure 5. Plots of the change in storage vs. time.

For this system to reach a new state of sustainable yield, the phreatophyte consumption must be eliminated entirely. Using the model, we can examine the phreatophyte use as a function of time. Figure 4 is a plot of the phreatophyte use in our system versus time since pumping was initiated. I have considered two transmissivities for the hypothetical system (1.0 and 0.5 ft^2/sec); both are high transmissivities. In the higher transmissivity aquifer, the phreatophyte consumption is very small after 400 years; in other words, the system has reached a new steady state in approximately 400 years. The new steady state is a sustainable development. In the lower transmissivity case, it takes approximately 900 to 1000 years for the phreatophyte consumption to be become very small.

In both aquifers, the phreatophytes are impacted faster where the pumping is closer to the phreatopytes (Case II). The point of considering Cases I and II is to show that the location of the pumping makes a difference in the dynamic response of the system. Most individuals, even trained hydrogeologists, are surprised at how slowly a water-table ground water system, like both the two systems simulated, responds to development.

We can look at the output from the model another way by examining the total amount of water removed from storage in our aquifers (Figure 5). In the high transmissivity aquifer, the amount of water removed from storage stabilizes in ~400 to 500 years, indicating we have reached a new steady state. Figure 5 shows that something of the order of 10^{11} cubic feet (approximately 3 million acre-feet) of water has been permanently removed from storage as the system changed to reach this new steady-state condition. This illustrates the important point that water must be removed from storage to reach a new steady state (sustainable) condition. In the lower transmissivity aquifer, water is still being removed from storage at 1000 years, and we have not yet reached a new steady state. In the lower transmissivity aquifer, ~5.7 million acre-feet of water have been removed from storage in 1000 years of pumping. Figure 5 again illustrates how slowly a water table aquifer responds.

It is important to notice that, even though the two developments (Case I and Case II) are equal in size, the aquifer responds differently depending on where the developments are sited. This again emphasizes the importance of studying the dynamics of the aquifer response: the response is different depending on where the development is located.

This example of our rather simple basin and range aquifer illustrates the importance of understanding the dynamics of aquifer systems. Again, while this is a simple example, the principles illustrated apply to aquifers everywhere. It is the rate at which the phreatopyte consumption can be captured that determines how this system reaches sustainability; this is a dynamic process. Capture always entails the dynamics of the aquifer system.

Conclusions

The idea that knowing the recharge (by which one generally means the virgin rate of recharge) is important in determining the size of a sustainable ground water development is a myth. This idea has no basis in fact.

The important entity in determining how a ground water system reaches a new equilibrium is capture. How capture occurs in an aquifer system is a dynamic process. For this reason, hydrologists are occupied in studying aquifer dynamics. The principal tool for these investigations is the ground water model.

These ideas are not new; Theis spelled them out in 1940. Somehow the ground water community seems to lose sight of these fundamental principles.

References

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Appendix

Conversion of Relevant Units—English versus Metric

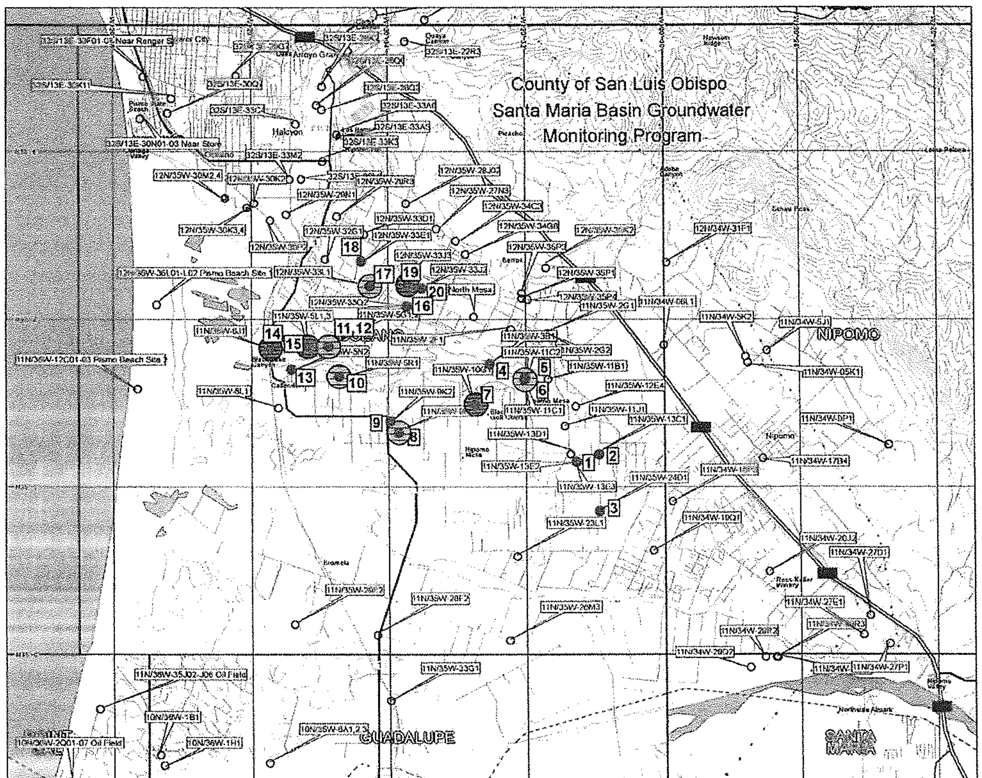
1 foot	=	0.305 m
1 mile	=	1.61 km
1 square foot	=	0.0929 m^2
1 square mile	=	2.59 km^2
1 acre-foot	=	1234 m^3
1 cubic foot per second (cfs)	=	0.0283 m^3/sec

Appendix C

Hydrographs for Nipomo Mesa Area

Nipomo Mesa Groundwater Resource Capacity Study
San Luis Obispo County, California

The County's Santa Maria Basin Groundwater Monitoring Program Database is the source of data for the hydrographs.



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 3500 ft Scale: 1 : 87,500 Detail: 11-2 Datum: NAD27

Legend:

- Hydrograph provided herein
- 0ft to 10 ft MSL
- Below sea level

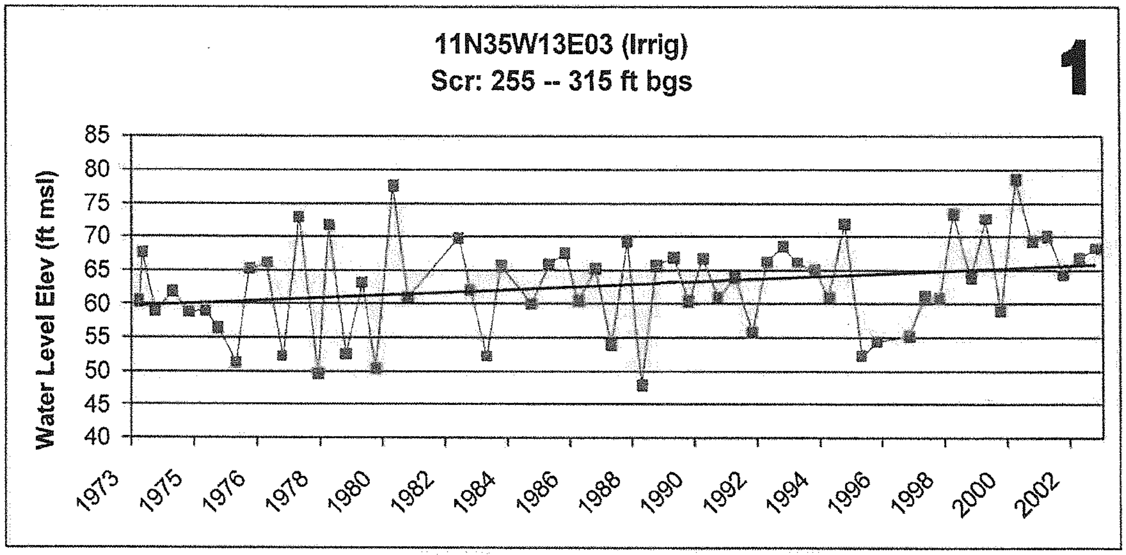
Notes:

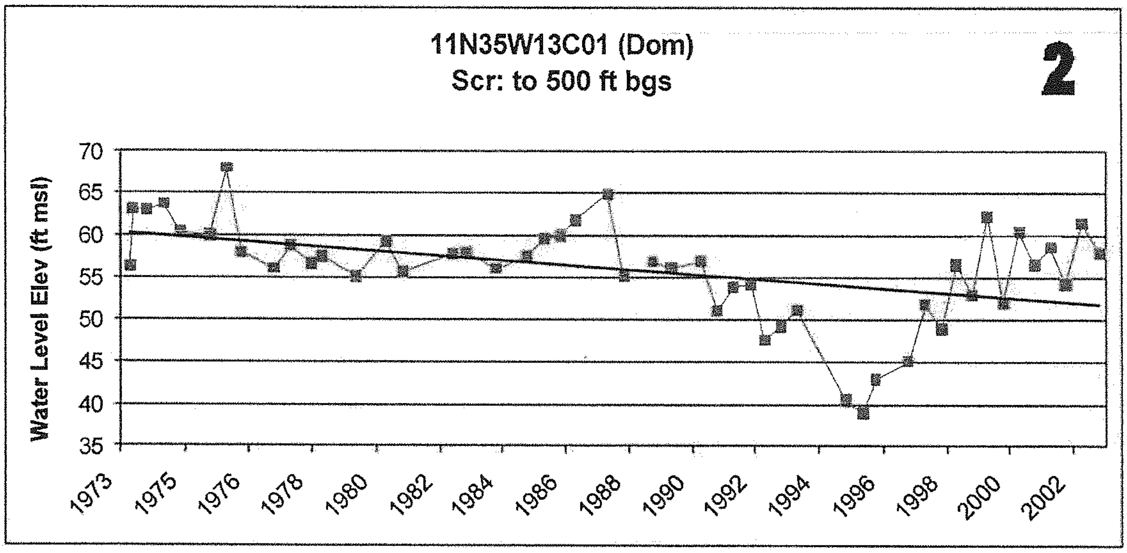
14) Non-pumping level -20 ft msl
Pumping level -30 ft msl

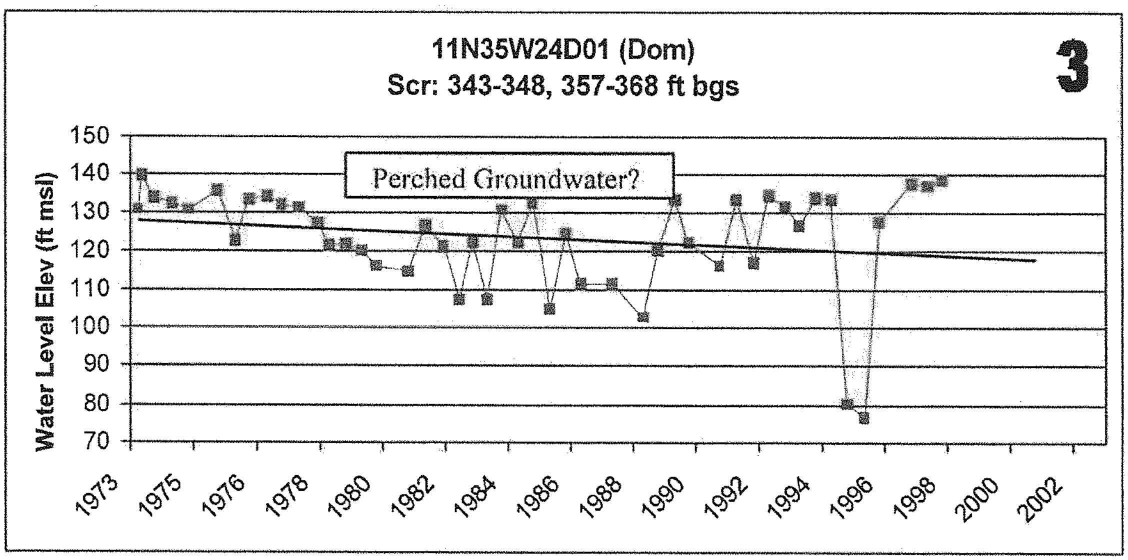
15) Non-pumping level -10 ft msl
Pumping level -40 ft msl

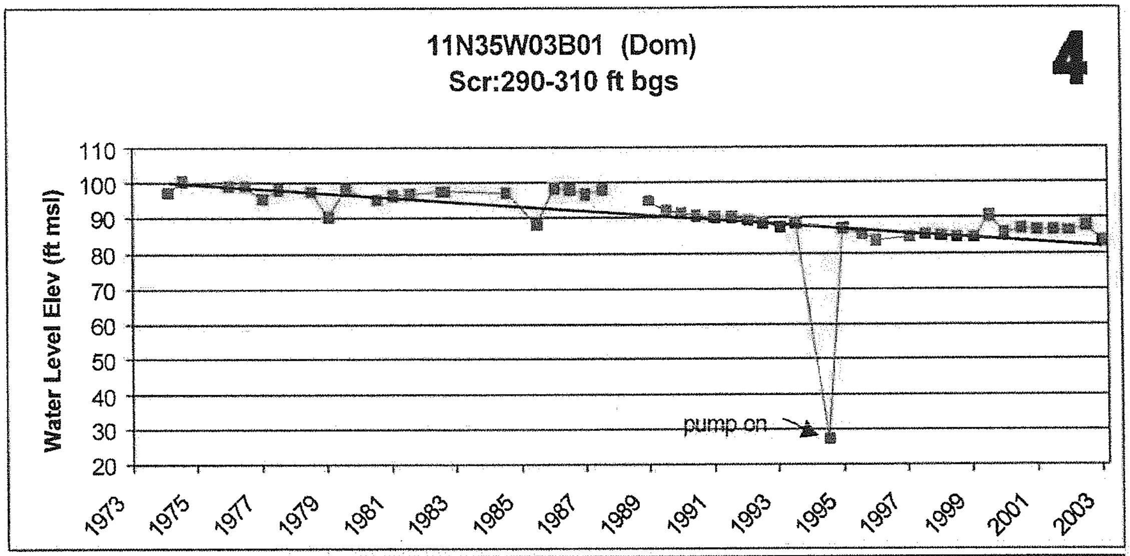
LOCATIONS OF SELECTED HYDROGRAPHS
COUNTY MONITORING WELL LOCATIONS
Nipomo Mesa Water Resource Capacity Study
San Luis Obispo County, California

Figure C-1

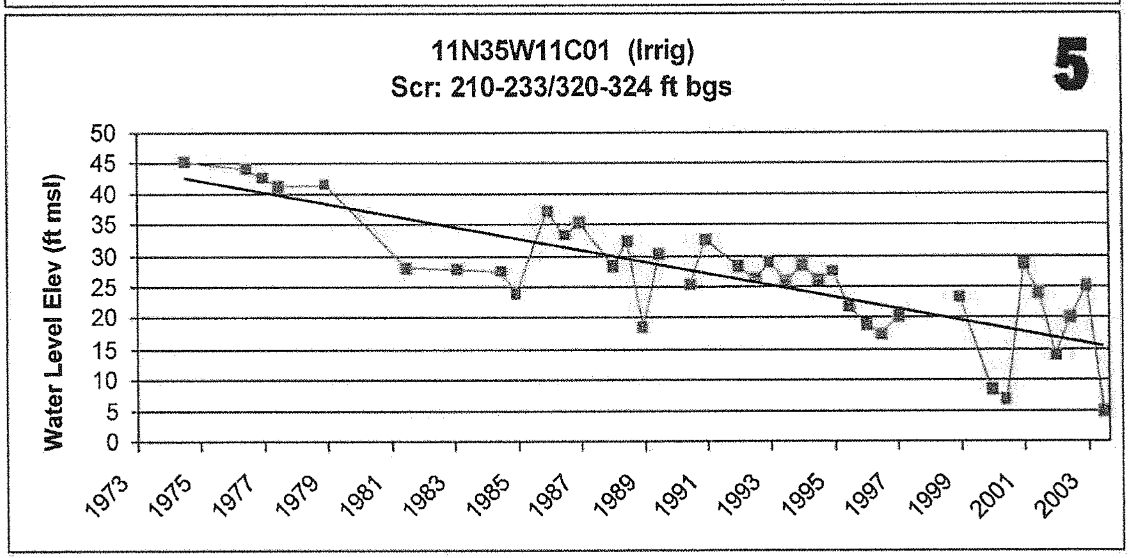

11N35W13E03 (Irrig)
Scr: 255 -- 315 ft bgs
1
Water Level Elev (ft msl)
85
80
75
70
65
60
55
50
45
40
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002


11N35W13C01 (Dom)
Scr: to 500 ft bgs
2
Water Level Elev (ft msl)
70
65
60
55
50
45
40
35
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

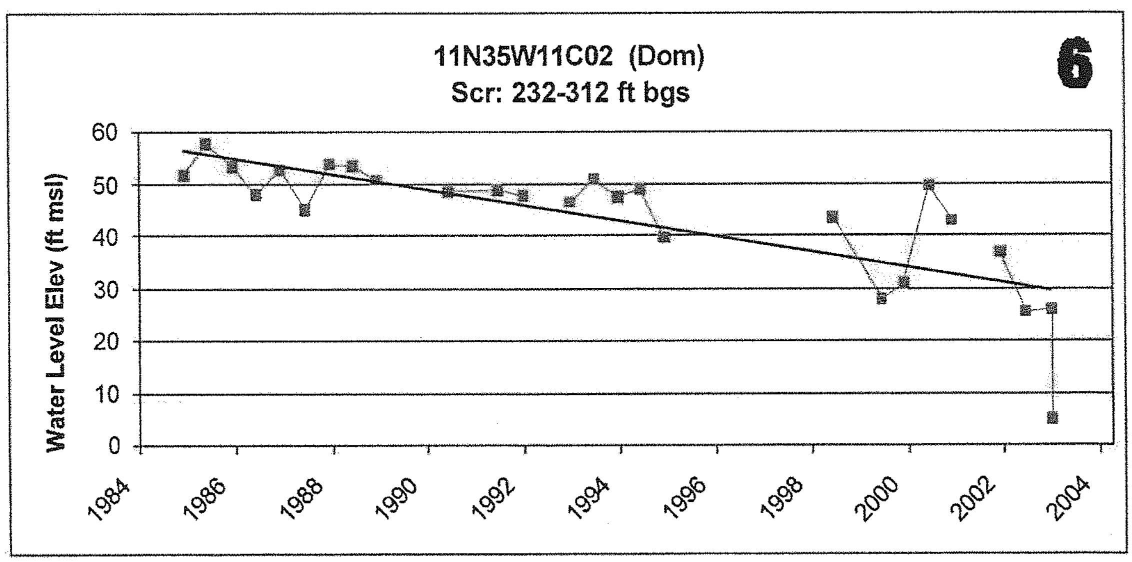

11N35W24D01 (Dom)
Scr: 343-348, 357-368 ft bgs
3
Perched Groundwater?
Water Level Elev (ft msl)
150
140
130
120
110
100
90
80
70
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002



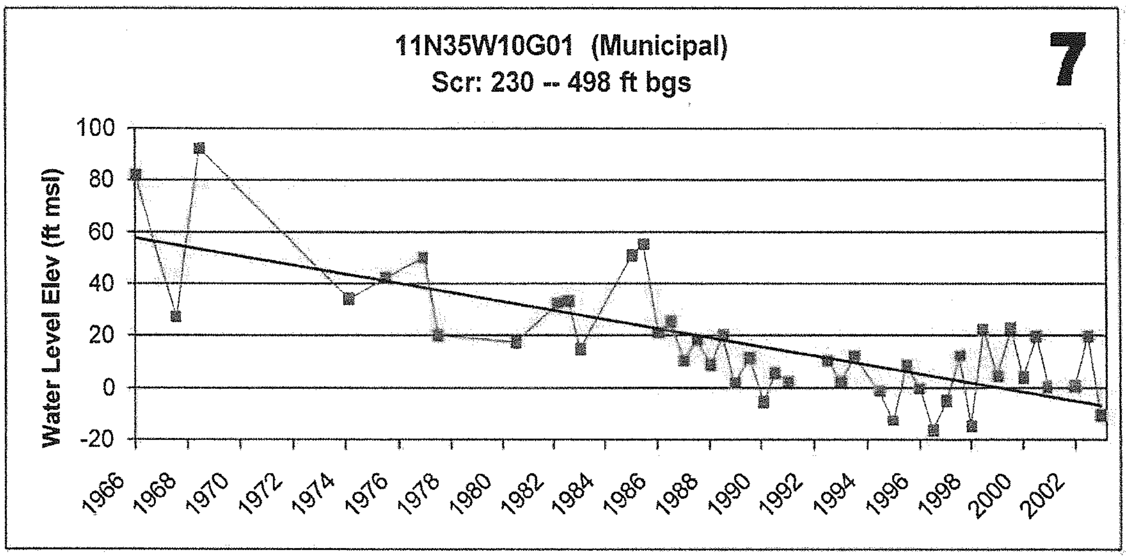
11N35W03B01 (Dom)
Scr:290-310 ft bgs
4
Water Level Elev (ft msl)
110
100
90
80
70
60
50
40
30
20
pump on
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003

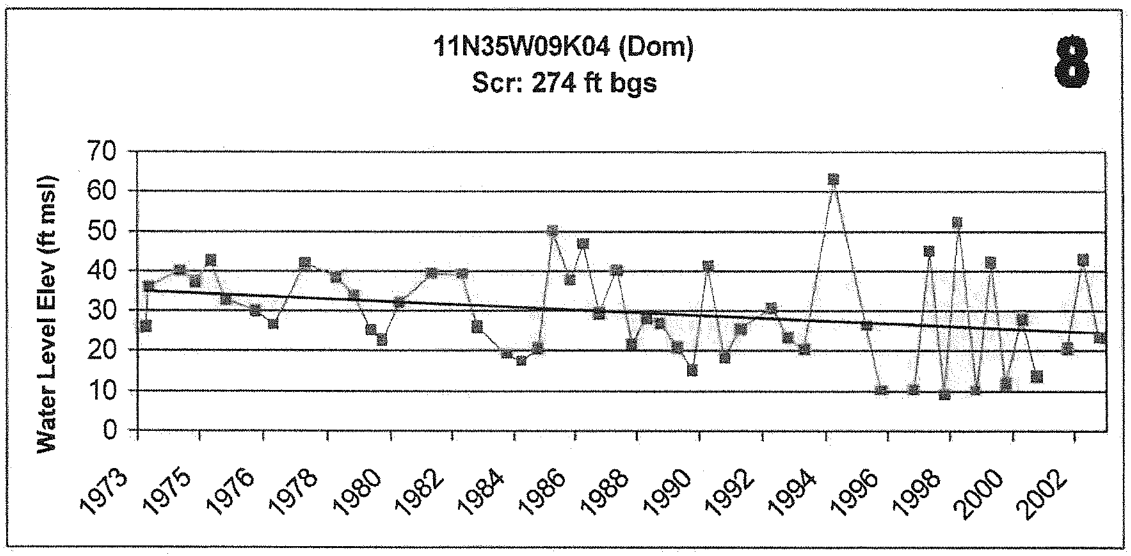


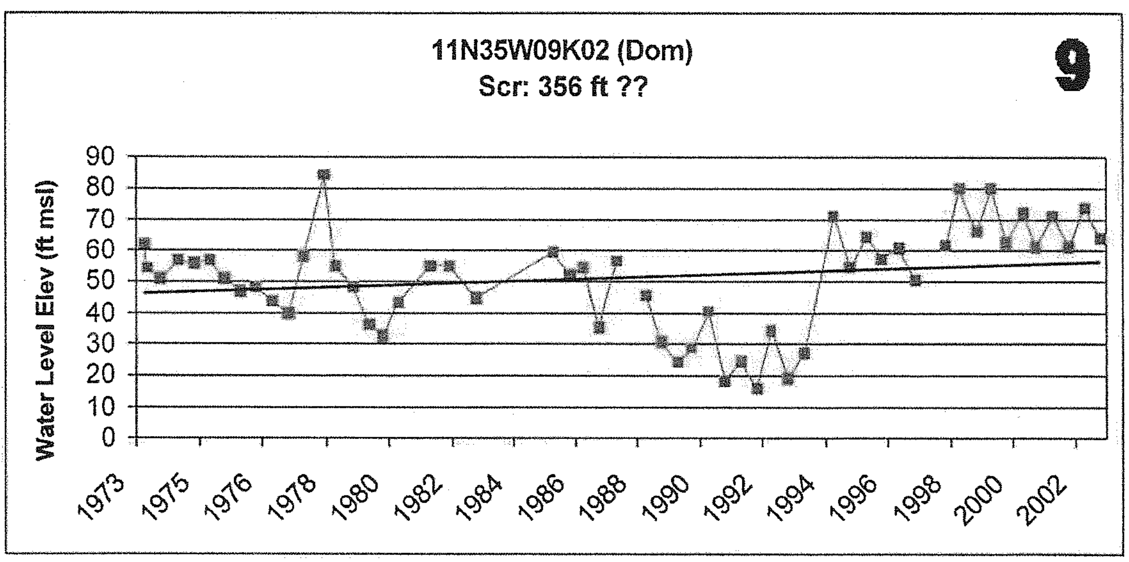
11N35W11C01 (Irrig)
Scr: 210-233/320-324 ft bgs
5
Water Level Elev (ft msl)
50
45
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003

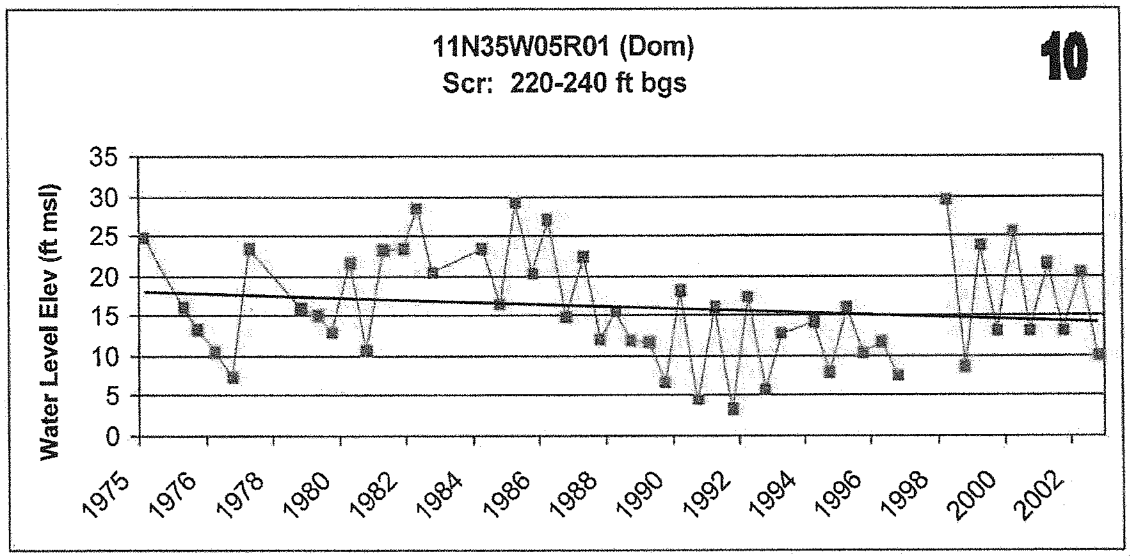


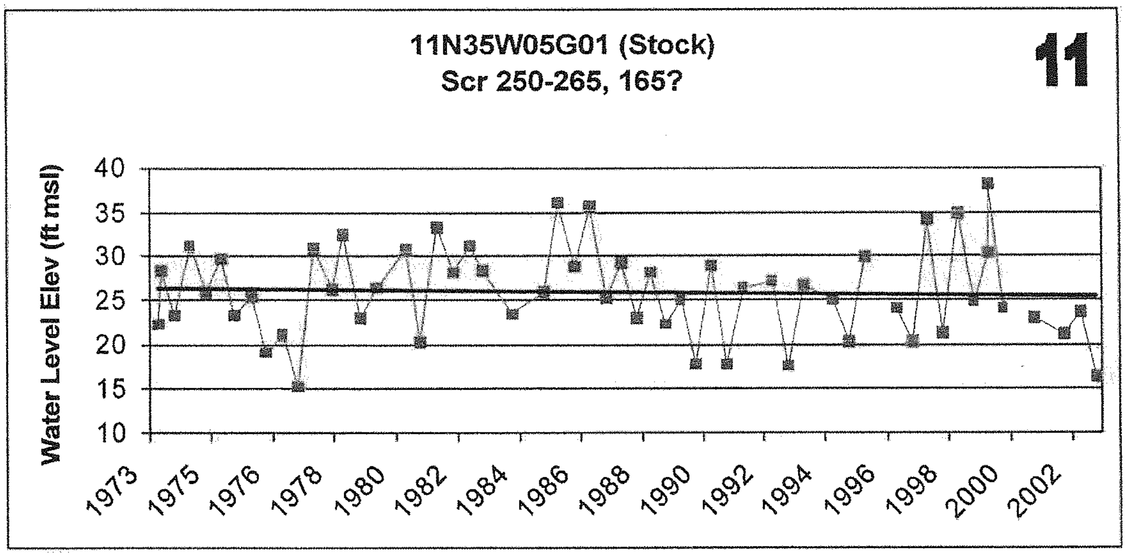
11N35W11C02 (Dom)
Scr: 232-312 ft bgs
6
Water Level Elev (ft msl)
60
50
40
30
20
10
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

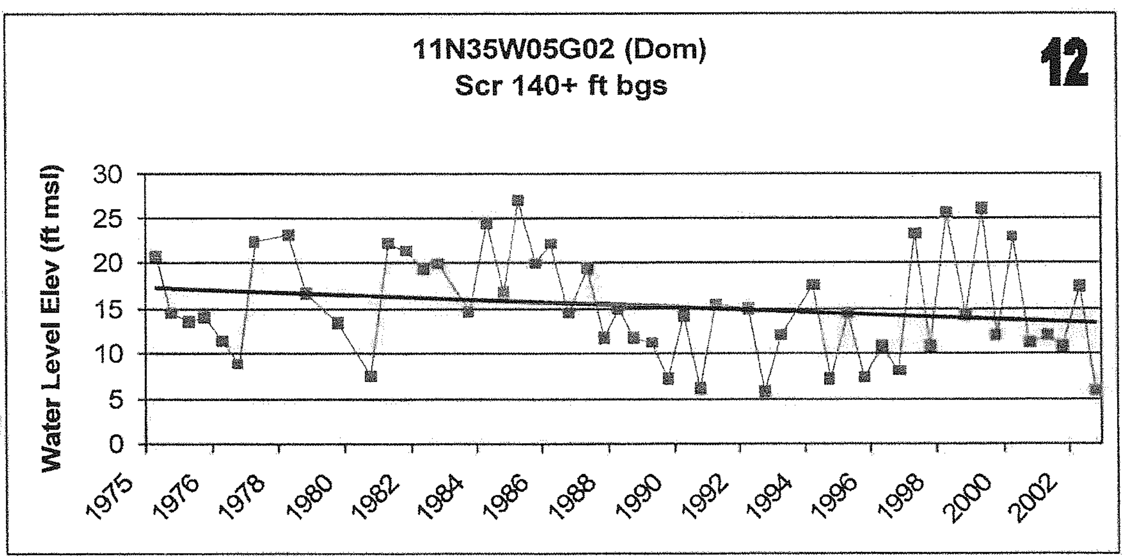

11N35W10G01 (Municipal)
Scr: 230 -- 498 ft bgs
7
Water Level Elev (ft msl)
100
80
60
40
20
0
-20
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

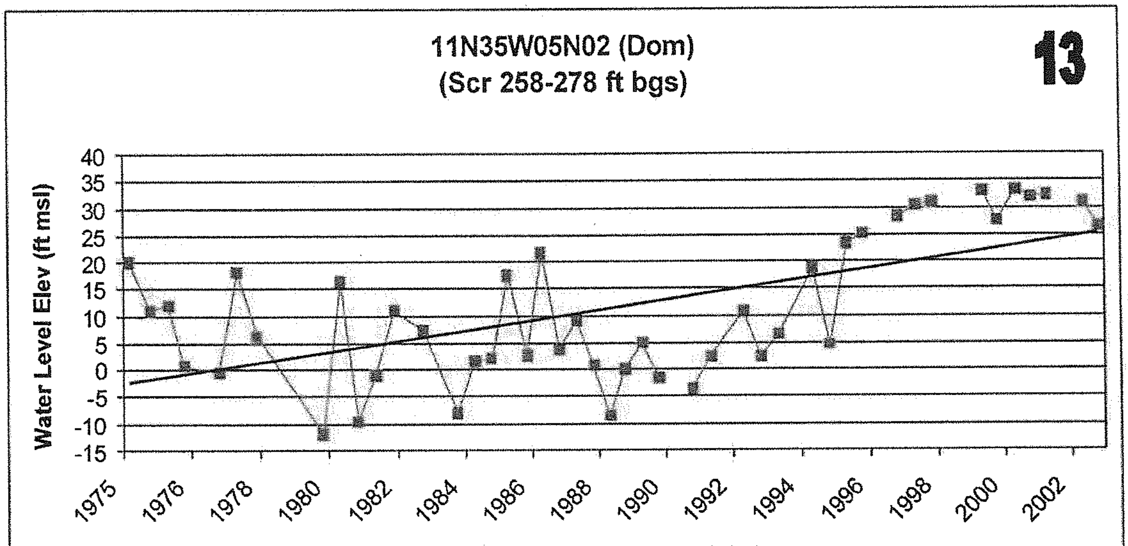

11N35W09K04 (Dom)
Scr: 274 ft bgs
8
Water Level Elev (ft msl)
70
60
50
40
30
20
10
0
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

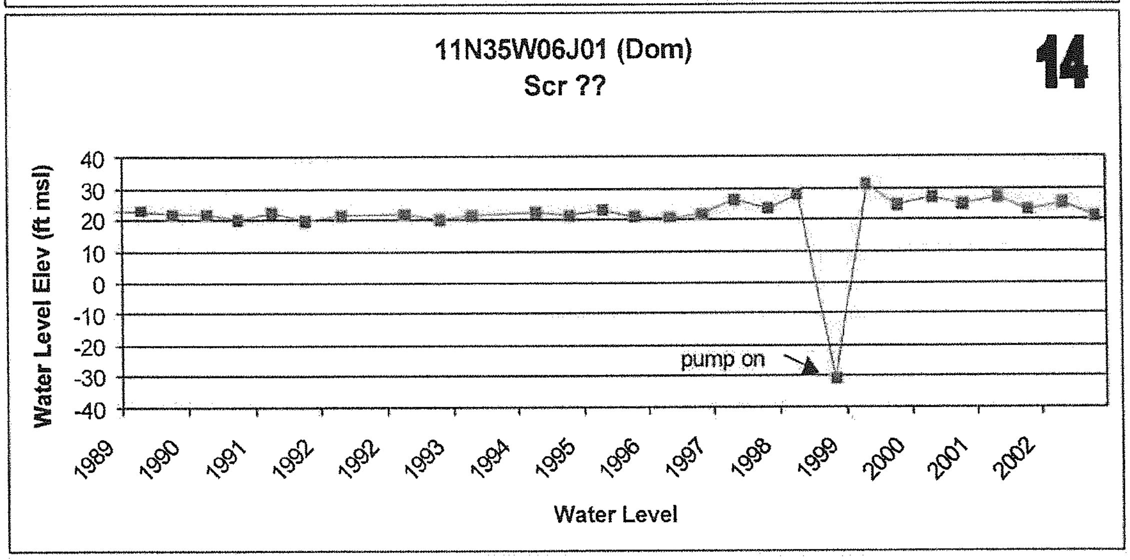

11N35W09K02 (Dom)
Scr: 356 ft ??
9
Water Level Elev (ft msl)
90
80
70
60
50
40
30
20
10
0
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

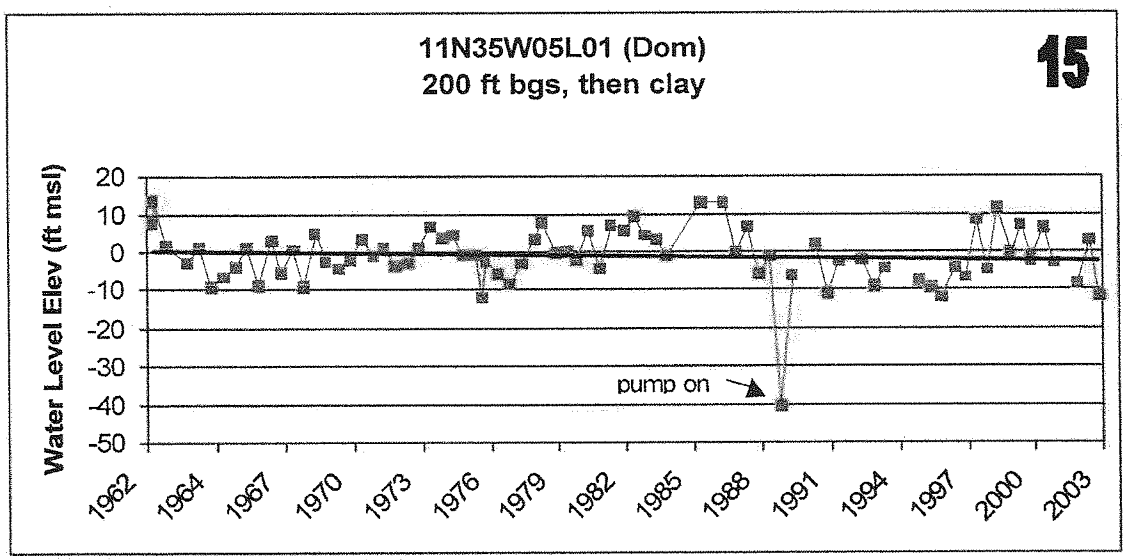

11N35W05R01 (Dom)
Scr: 220-240 ft bgs
10
Water Level Elev (ft msl)
0
5
10
15
20
25
30
35
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

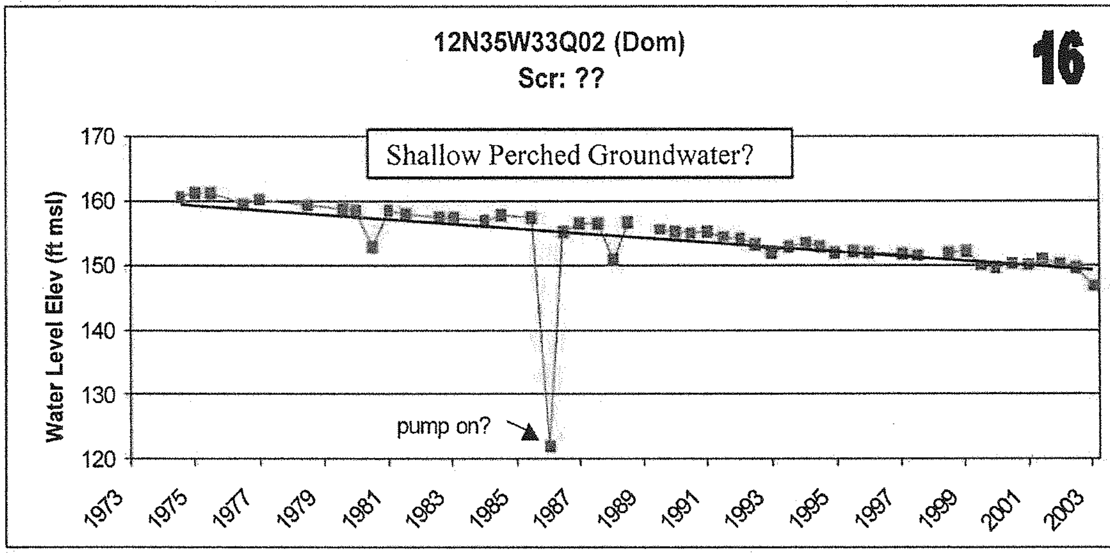

11N35W05G01 (Stock)
Scr 250-265, 165?
11
Water Level Elev (ft msl)
10
15
20
25
30
35
40
1973
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

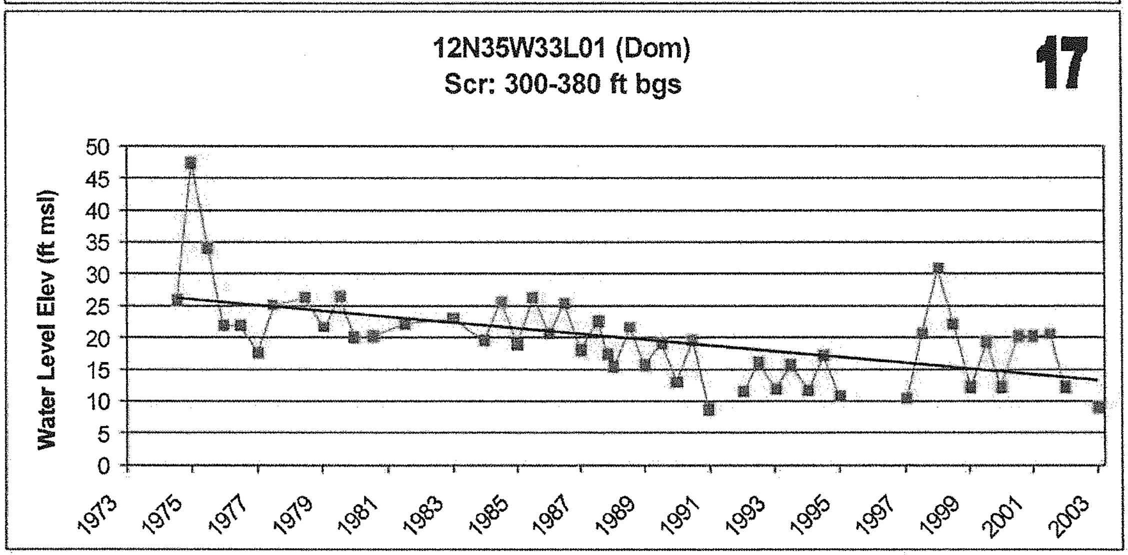

11N35W05G02 (Dom)
Scr 140+ ft bgs
12
Water Level Elev (ft msl)
0
5
10
15
20
25
30
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

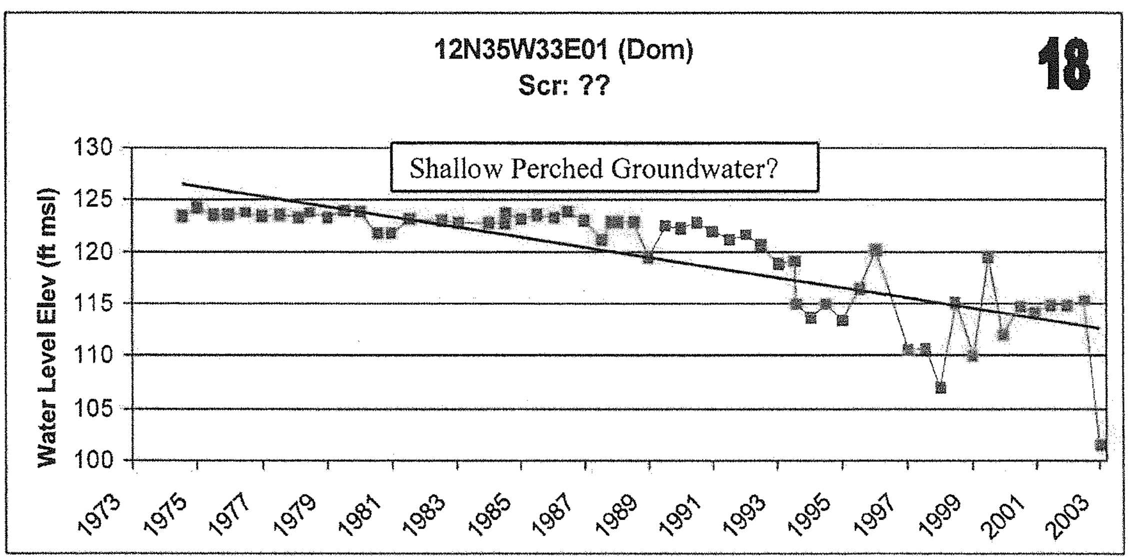

11N35W05N02 (Dom)
(Scr 258-278 ft bgs)
13
Water Level Elev (ft msl)
40
35
30
25
20
15
10
5
0
-5
-10
-15
1975
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002

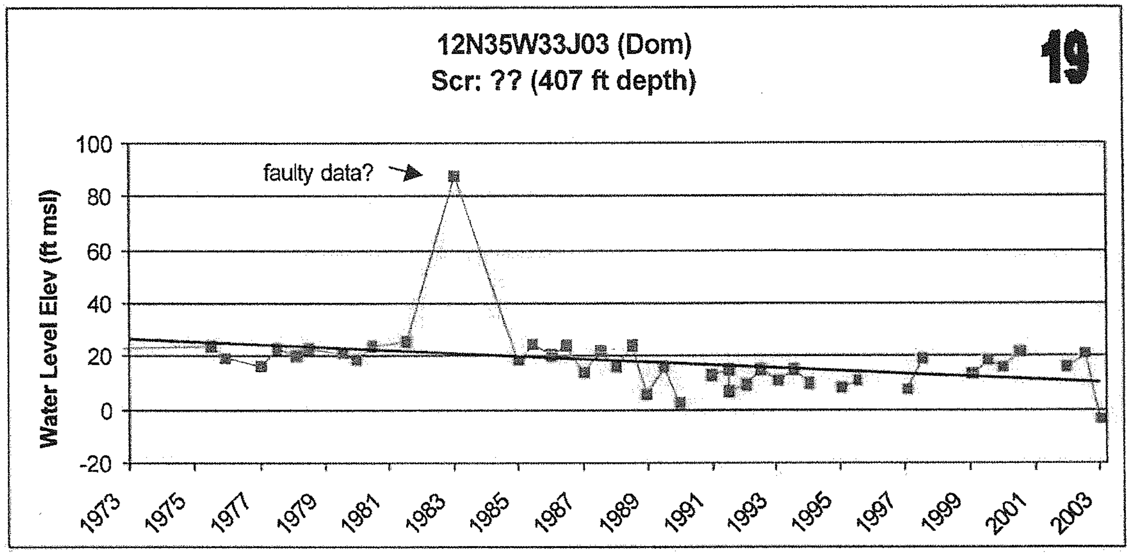

11N35W06J01 (Dom)
Scr ??
14
Water Level Elev (ft msl)
40
30
20
10
0
-10
-20
-30
-40
pump on
1989
1990
1991
1992
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Water Level

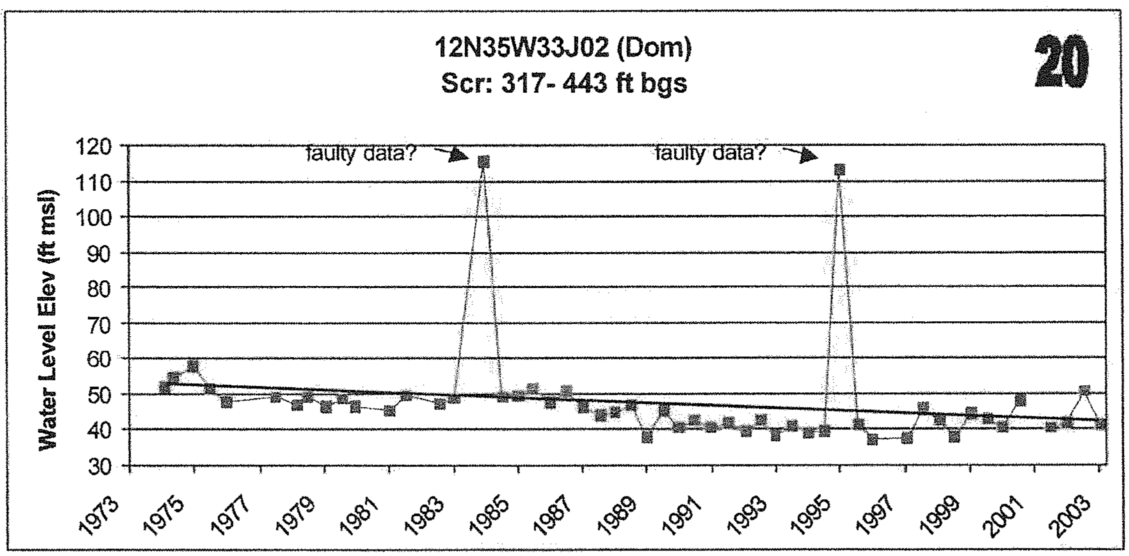

11N35W05L01 (Dom)
200 ft bgs, then clay
15
Water Level Elev (ft msl)
20
10
0
-10
-20
-30
-40
-50
pump on
1962
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003


12N35W33Q02 (Dom)
Scr: ??
16
Shallow Perched Groundwater?
pump on?
Water Level Elev (ft msl)
170
160
150
140
130
120
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003


12N35W33L01 (Dom)
Scr: 300-380 ft bgs
17
Water Level Elev (ft msl)
50
45
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003


12N35W33E01 (Dom)
Scr: ??
18
Shallow Perched Groundwater?
Water Level Elev (ft msl)
130
125
120
115
110
105
100
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003


12N35W33J03 (Dom)
Scr: ?? (407 ft depth)
19
Water Level Elev (ft msl)
faulty data?
100
80
60
40
20
0
-20
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003


12N35W33J02 (Dom)
Scr: 317- 443 ft bgs
20
Water Level Elev (ft msl)
faulty data?
faulty data?
120
110
100
90
80
70
60
50
40
30
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003

Appendix D

Summary Documentation of Modeling to Evaluate Saltwater Intrusion

Nipomo Mesa Groundwater Resource Capacity Study
San Luis Obispo County, California

Appendix D
Summary Description of Groundwater Models

MODLOW/MT3D Model

Modeling was conducted using MODFLOW (McDonald and Harbaugh, 1988) and MT3D (Zheng, 1990, 1999) to represent a cross-section of the coastal aquifer perpendicular coastal margin. The model cross-section is 80,000 feet long, 1000 feet deep, and consists of one row, forty 2000-foot-wide columns, and thirteen layers most of which are approximately 60 feet thick. The coastal margin is at the center of the model (40,000 feet), and the offshore slope of the model aquifer is based on bathymetric contours on the San Luis Obispo 1:100,000 USGS topographic map.

Constant head is specified at the upgradient margin and at the top layer offshore of the coastal margin to produce a horizontal hydraulic gradient of 0.00125. Uniform horizontal and vertical hydraulic conductivity of 10 and 1 ft/d, respectively, was assigned to the aquifer, and extremely high conductivity of 100,000 ft/d is assigned to the represent the sea. Aqufier storage and specific yield were assigned as 0.001 and 0.25, respectively. Initial concentration of 19,000 mg/l was specified for the sea, initial concentration of 0 mg/l was specified for the aquifer.

Pumping was simulated a distance of 15,000 feet inland of the coastal margin from a well screened from –100 to –800 ft MSL. Change in head and concentration was monitored in the middle portion of the aquifer beneath the coastal margin. Results are discussed in Section 5.3 of the report.

SEWAT Model

Modeling was also conducted using SEAWAT (Guo and Langevin, 2002), which is a specialized version of MODFLOW/MT3D that also accounts for variable fluid density. Model design and assigned properties are similar to the MODFLOW/MT3D model described above, except for the SEWAT model the discretization is much finer.

The model represents a cross-section of the aquifer system perpendicular to the coastline. It is 60,000 feet long and 900 ft deep and consists of 629 columns and 60 layers. The shoreline is at the center 30,000 ft from both ends of the model. The slope of the seafloor is based on bathymetric contours from the USGS San Luis topographic quadrangle.

Model inflow includes constant head at upland margin and uniform recharge of 4 inches per year (25% of average rainfall). Regional horizontal hydraulic gradient is approximately 0.00125. Horizontal and vertical hydraulic conductivity was assigned is 10 and 1 ft/day, respectively. Dispersivity is 50 feet.

First, the model was run without any pumping to achieve an equilibrium position for the saltwater-freshwater interface. Then pumping was assigned 15,000 from the inland from the shore at a depth interval between 100 ft to 600 ft below the water table. Increase in salinity with time a various depths 3000 feet inland of the coastline was evaluated in response to pumping 15,000 feet inland. Results are discussed in Section 5.3 of the report.

Nipomo Supplemental Water Project
Groundwater Impact Review

The Nipomo Mesa Management Area (NMMA) Technical Group is one of three management area committees charged with developing the technical bases for sustainable management of surface and groundwater supplies available to each of the management areas. Each management area was established to promote monitoring and management practices so that present and future water demands are satisfied without causing long-term damage to the underlying groundwater resource. The NMMA lies between the Northern Cities Management Area to the north and the Santa Maria Valley Management Area to the south.

The NMMA Technical Group was established as a component of the court judgment in the Santa Maria Groundwater Basin litigation (Judgment). The Judgment incorporates an agreement between most of the parties to the litigation, which is referred to as the Stipulation. The Technical Group includes representatives appointed by the Nipomo Community Services District, Golden State Water Company, Woodlands Mutual Water Company, ConocoPhillips, and agricultural property owners.

The Technical Group has reviewed the proposed Nipomo Supplemental Water Project (Project), which includes a water purchase agreement with the City of Santa Maria (City) for a supplemental water source, and a pipeline for delivery of that supplemental water from the City to the Nipomo Mesa. This document provides a qualitative assessment of potential impacts of the Project on the groundwater resources of the NMMA.

Project Description

The Stipulation includes a requirement for the Nipomo Community Services District to purchase from the City a minimum of 2,500 acre-feet of water each year to supplement and recharge groundwater resources within the NMMA. The Stipulation also requires Nipomo Community Services District, Rural Water Company, Woodlands Mutual Water Company, and Golden State Water Company to share in the cost and use of the supplemental water.

The Project includes the purchase of water from the City and the construction of facilities to deliver (i.e. a pipeline), store, and blend this water with purveyor well water. Supplemental water from the City delivered to the NMMA would be used to reduce groundwater production from wells in the NMMA by the Nipomo Community Services District and other participating purveyors. Of the 3,000 acre-feet per year (AFY) included in a wholesale agreement with the City, 2,500 AFY would be used in compliance with the Stipulation. The remaining 500 AFY would be used to meet a previously planned increase in Nipomo Community Services District demand, as described below.

Of the planned 3,000 AFY of supplemental water, 2,500 AFY would directly offset groundwater production by some proportion of use by each of the funding NMMA purveyors (Figure 1). The reduction in groundwater production would be principally in the area of the pumping depression near the central portion of the NMMA. A pumping depression is a localized area of lowered groundwater levels that can negatively impact a groundwater basin. A pumping depression may also influence the migration of saline groundwater typically found near the ocean and coast, inland toward or into, purveyor wells located within the area of lowered groundwater levels. This phenomenon is referred to as seawater intrusion.

Existing and planned system connections (i.e. via pipeline) between several purveyors, including Nipomo Community Services District, the Woodlands Mutual Water Company, Rural Water Company, and Golden State Water Company, would allow full use of the supplemental water available from the Project. Depending on the nature and management of these connections, reduced groundwater production would occur at one or more locations within these purveyors' well fields. The implementation and use of such connections for the purpose of groundwater basin management is documented in the January 2010 NMMA Purveyor Well Management Plan.

Some possible pumping scenarios resulting in reduced production from certain wells within each purveyor's well field are summarized in Table 1. These scenarios reflect the delivery of up to 2,500 AF of supplemental water to the Nipomo Mesa, with the amount of water delivered to each purveyor differing depending on the number of purveyor connections considered for each scenario (Table 1). As summarized in Table 1, four scenarios were considered based on current projections.

In all scenarios presented, total groundwater production by purveyors would be reduced to approximately 50 percent of current production. For Scenario 2 through Scenario 4, groundwater production for any one purveyor may be reduced as little as 20 percent (i.e. under Scenario 2, for Golden State Water Company) to as much as 70 percent (i.e. under Scenario 4, for Nipomo Community Services District). If supplemental water is not delivered to any other purveyor, groundwater production from specific wells operated by the Nipomo Community Services District could be reduced by 100 percent (i.e. under Scenario 1, Table 1). It should be noted that the scenarios summarized in Table 1 do not include 500 AFY of the planned 3,000 AFY of supplemental water, which would be used by the Nipomo Community Services District for potential future customers within existing district boundaries, consistent with the current San Luis Obispo County General Plan.

Source of Supplemental Water

The City would supply supplemental water from its potable water distribution system, which contains a combination of groundwater and State Water Project (State) water delivered from northern California. The City produced 10,000 to 12,000 AFY of groundwater from its seven wells in the thirteen years prior to receiving delivery of State water in 1997. Since then, the City's groundwater production has been less than 3,045 AFY.

The City's Urban Water Management Plan confirms that its State contract entitles it to receive up to 17,800 AFY of State water. The Stipulation requires that the City use no less than 10,000 AFY of available State water, or its full allocation of State water, if the amount available is less than 10,000 AF in a given year. The remainder of the City's water supply in any given year would be obtained from local groundwater.

The ratio of groundwater to State water that would be delivered to the NMMA would vary from year to year, in response to water demands, any restrictions in the amount of delivered water, and distribution system constraints. In 2010, the City used 10,207 AF of State water (77 percent of its total water supply) and 3,044 AF of groundwater (23 percent of its total water supply). The City's Urban Water Management Plan forecasts that deliveries of State water will remain at about 10,000-11,000 AFY, assuming a reliability factor of 60 percent. The remainder would come from groundwater as demands increase (including the transfer of water to the Nipomo Community Services District). Forecasted groundwater production by the City in the year 2035 would be 9,070 AF.

The delivery of supplemental water to the NMMA most likely would require the City to increase its groundwater production compared to current levels. However, the City's groundwater use is expected to remain well below its historical maximum. To the extent the City is required to increase its groundwater production to provide supplemental water to the NMMA beyond that required for in-City uses, comparatively lower groundwater levels at the City's well field are expected. However, the City's well field is located six miles southeast of the NMMA, and more than 10 miles east of the ocean.

Impact on NMMA Groundwater Production

The 2,500 AFY of supplemental water delivered to the NMMA amounts to an increase in the overall water supply, and would reduce purveyor groundwater production from the NMMA by that amount within and near the existing pumping depression. In addition, the water that percolates back into the ground after use (termed "return-flow") is an increase in to the NMMA and may be as much as 300 AFY from the 500 AFY of additional water provided to the Nipomo Community Services District. The amount of reduced groundwater production for each purveyor would depend on the nature of any connection to deliver the supplemental water.

The 2,500 AFY of supplemental water delivered to purveyors would offset approximately 50 percent of their local groundwater production, based on 2010 data (Table 1). In response to the reduction in groundwater production and, to a lesser extent, the increased return-flow resulting from the Project, groundwater levels are expected to rise significantly, particularly in the pumping depression in the central portion of the NMMA (Figure 1).

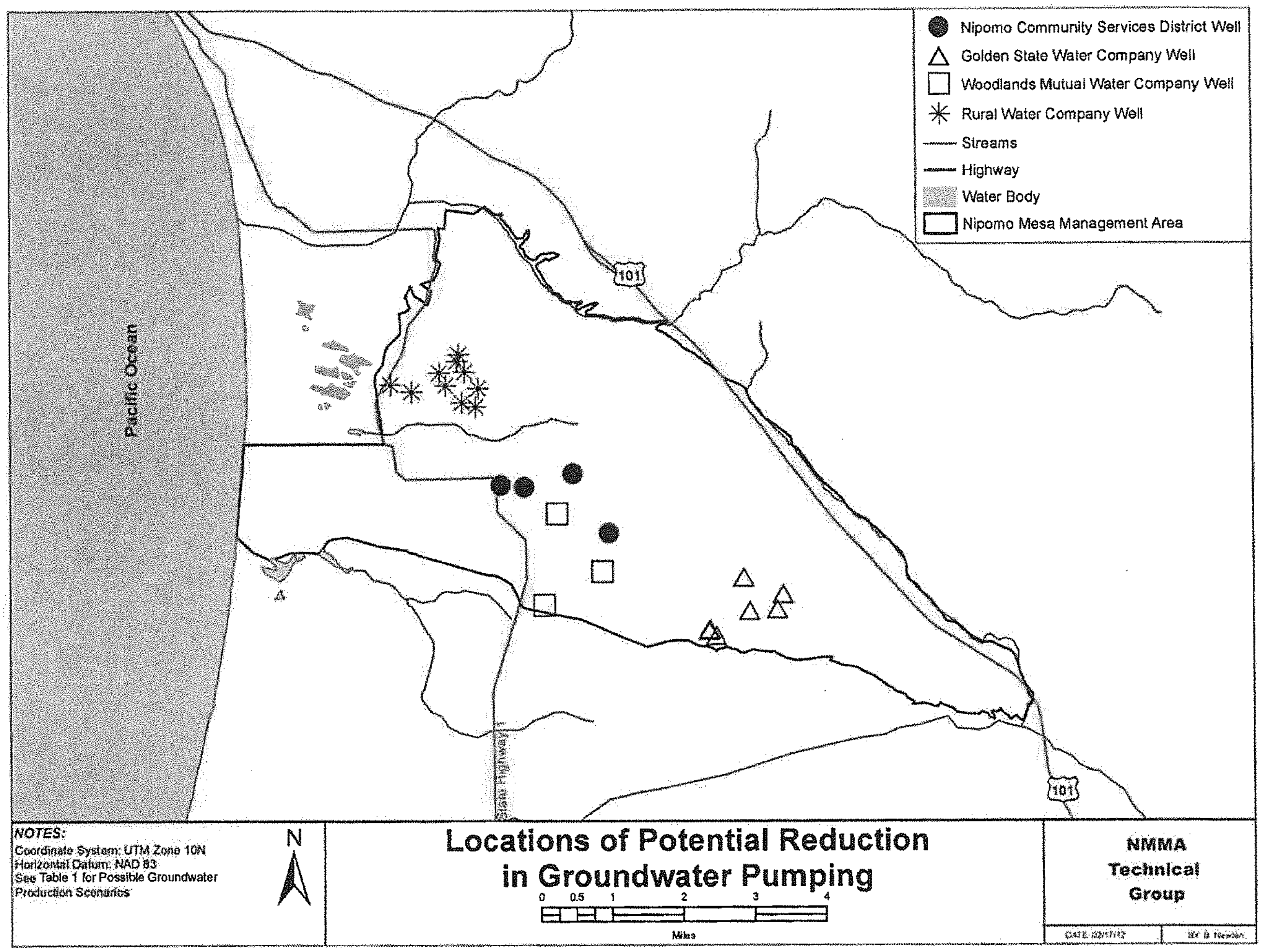
Impact on Potential Seawater Intrusion

The delivery of supplemental water from the City would reduce the potential for seawater intrusion into the NMMA. This reduction in the potential for seawater intrusion results principally from shrinking of the area of lowered groundwater levels (i.e. the pumping depression) as groundwater levels rise. The NMMA Technical Group regularly considers seawater intrusion threats in its evaluation of water conditions, such as the threat posed by the documented seawater intrusion event north of the NMMA in 2009.

Table 1
Possible Groundwater Production Scenarios[1]
(Approximate AFY)

	Nipomo Community Services District[2]	Golden State Water Company[2]	The Woodlands Mutual Water Company[2]	Rural Mutual Water Company[2]	Total (Percent of 2010 Production)
Current Scenario (2010 Production)[3]	2,370	1,060	850	720	5,000
Scenario 1:Delivery to Nipomo Community Services District Only - No Connections	0	1,060	850	720	2,630 (52%)
Scenario 2: Add Golden State Water Company Connection	80	850	850	720	2,500 (50%)
Scenario 3: Add Golden State Water Company and Woodlands Mutual Water Company Connections	495	850	435	720	2,500 (50%)
Scenario 4: Add Golden State Water Company, Woodlands Mutual Water Company, and Rural Water Company Connections	705	850	435	510	2,500 (50%)

[1]Based on 2,500 AFY of available supplemental water and 2010 demand met by specific wells.
[2]See Figure 1 for the location of specific wells where reduced production would occur.
[3]For specific wells where reduced production would occur under alternative scenarios.



Locations of Potential Reduction in Groundwater Pumping

Fw: Nipomo Park EIR - December 18, 2012

Board of Supervisors to: Adam Hill, Amy Gilman, Bruce Gibson, Cherie Aispuro, Debbie Geaslen, Frank Mecham, James Patterson, Paul 12/17/2012 01:28 PM

Sent by: Amber Wilson

Cc: cr_board_clerk Clerk Recorder, Curtis Black

----- Forwarded by Amber Wilson/BOS/COSLO on 12/17/2012 01:28 PM -----

From: deah rudd <deahrudd@att.net>
To: boardofsups@co.slo.ca.us, ekavanaugh@co.slo.ca.us
Cc: HARRY Walls <harryfwalls@sbcglobal.net>
Date: 12/17/2012 12:57 PM
Subject: Nipomo Park EIR - December 18, 2012

Dear Board of Supervisors:

I am asking the Board to deny approval of the Nipomo Park Master Plan EIR based on the analyses ssubmitted by the Nipomo Park Conservancy and the following:

1. The beauty in this park will be forever lost if it is paved over and build out as requested. The nature that abounds in the Woodlands is priceless. There is peace and tranquility for all to enjoy and a buffer from the noise and confusion of the city. Meandering equestrian trails are safer than trails stacked too close to one another as proposed. The wildlife in the park for all who have enjoyed in the past - the owls, the squirrels, the rabbits, the coyote, the hawks, fox, birds, etc. will be displaced and lost in this region. This is a regional park and should be preserved as such. Mass development does not fit in this area.

2. There is an inadequate supply of water to support this development. Each Spring and Winter I watch the water level reading of my County monitored well drop. Even though it is on an upper stratus of the aquifer under the park, it has been trending downward for the last several years and has lost 6 1/2 feet in the last several years. Sea water intrusion is imment if it continues to drop. I will not only loose water for me and my family and property but for my horses, dogs, cats and chickens. This will make my land nearly worthless and I will have to move. The Board bears a responsibilty to protect the livelihood of all the residents, animals and landscape that depend on the Nipomo Mesa Aquifer.

3. Other sites need to be analyzed for the amenities being requested. Just like the idea

Item # **44** Meeting Date: **12/18/2012**

Presented by: Deah Rudd

Received prior to meeting and posted to web on: **December 17, 2012** several years ago to build the Nipomo High School on the park land, this development is illogical. To cluster all of this development at the park is a waste of existing resources throughout the county. There is a buffer of land between the High School and the community which was reserved for additional ball fields. It is time for government to work together and pool their resources and amenities for the public good.

4. The infrastructure is inadequate to support the development at the park. The traffic created by this proposed development would be unimaginable. It is already a nightmare to travel down Tefft at peak times of the day. The Willow off-ramp (which I didn't see in the traffic analysis unless I missed it) will also bring more traffic to Pomeroy and this neighborhood.

5. The economy is in a downward trend for the next three years. There is no reason this development is needed and the EIR does not support that it is needed at this time or at all.

6. The fact that the Nipomo Area Recreation Association (NARA) has been suspended is troubling to me. I understand this affects their insurance and they cannot transact business or enforce contracts (any contract executed by a suspended association is voidable at the demand of the other party).

7. The County is gifting the parks public resources to NARA which is against the law.

8. The EIR is treating the park as a new park which it is not.

Thank you,

Deah Rudd

1189 Mesa View Dr.

Arroyo Grande, CA 93420

805-710-2739

To: Adam Hill/BOS/COSLO@Wings, Amy Gilman/BOS/COSLO@Wings, Bruce Gibson/BOS/COSLO@Wings, Cherie Aispuro/BOS/COSLO@Wings, Debbie Geaslen/BOS/COSLO@Wings, Frank Mecham/BOS/COSLO@Wings, James
Cc: cr_board_clerk Clerk Recorder/ClerkRec/COSLO@Wings, Curtis Black/GenSrvcs/COSLO@Wings,
Bcc:
Subject: Fw: 5 Nipomo Park Master Plan documents entered into record
From: Board of Supervisors/BOS/COSLO - Monday 12/17/2012 02:26 PM
Sent by: Amber Wilson/BOS/COSLO

----- Forwarded by Amber Wilson/BOS/COSLO on 12/17/2012 02:25 PM -----

From: Cynthia Hawley <cynthiahawley@att.net>
To: boardofsups@co.slo.ca.us
Date: 12/17/2012 01:56 PM
Subject: 5 Nipomo Park Master Plan documents entered into record

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Attached is the fifth set of documents in the series of documents entered into the administrative record regarding the upcoming hearing on the Nipomo Park Master Plan.

Cynthia Hawley
Cynthia Hawley, Attorney at Law
P.O. Box 29
Cambria, CA 93428
Phone: (805) 927-5102
Facsimile: (805) 927-5220
cynthiahawley@att.net

2010_RMS for south county.pdf
Joint Use Agreement 1.pdf
Joint Use Agreement 2.pdf
Parks&Rec Project List.pdf
stipulated judgment of basin litigation.pdf

Item # **44** Meeting Date: **12/18/2012**

Presented by: Cynthia Hawley

Received prior to meeting and posted to web on: **December 17, 2012**

2009-2010

Annual Resource Summary Report

San Luis Obispo County General Plan

Board of Supervisors

Frank R. Mecham, Chairperson, District 1
Bruce S. Gibson, District 2
Adam Hill, District 3
Paul Teixeira, District 4
James R. Patterson, District 5

Staff

Jason Giffen, Planning and Building Director
Kami Griffin, Assistant Planning and Building Director
Chuck Stevenson, AICP, Long Range Planning Division Manager
Mike Wulkan, Supervising Planner
James Caruso, Senior Planner – Project Manager
Amy Ashley – Student Intern
Stephanie Thorne – Student Intern

I. INTRODUCTION

Scope and Purpose

This is the 2009-2010 edition of the Resource Management System's (RMS) Annual Summary Report (ASR) covering the fiscal year July 2009 through June 2010. This report is based on information gathered from service providers, county agencies, reports from state or regional agencies, environmental impact reports for major projects, research for the Land Use and Circulation Element Update program, and personal communications with agency staff. Additional resource information is provided by staff of the incorporated cities, community services districts, school districts, other special districts and private water companies.

The ASR's primary purpose is to provide a comprehensive yearly summary of the state of the county's natural and man-made resources. The ASR is meant to inform the public, staff and decision makers regarding resource and infrastructure issues.

About the Resource Management System

The Resource Management System (RMS) provides information to guide decisions about balancing land development with the resources necessary to sustain such development. It focuses on:

- Collecting data
- Identifying resource problems; and
- Recommending solutions.

When a resource deficiency becomes apparent, several courses of action are possible to protect the public health, safety and welfare:

- The resource capacity may be expanded;
- Conservation measures may be introduced to extend the availability of unused capacity;
- Resource efficiencies may be introduced;
- Development may be restricted or redirected to areas with remaining resource capacity.

In this way, the RMS addresses development in terms of appropriate distribution, location, and timing rather than growth versus no-growth. Recommended actions in the ASR may also address resource use by existing development and improvements in resource efficiencies.

The RMS uses three alert levels called levels of severity (LOS) to identify differing levels of resource deficiencies. Level I is the first alert level and occurs when sufficient lead time exists either to expand the capacity of the resource, or to decrease the rate at which the resource is being depleted. Level II identifies the crucial point at which some moderation of the rate of resource use must occur to prevent exceeding the resource capacity. Level III occurs when the demand for the resource equals or exceeds its supply and is the most critical level of concern. The County should take a series of actions to address resource deficiencies before Level III is reached.

The RMS also lists a variety of steps which can be taken by the Board of Supervisors when it is determined that a resource has reached a particular level of severity. These are referred to as "action requirements," and they are found in the body and appendix of this report.

It is important to distinguish between "recommended" levels of severity and levels of severity that have been certified by the Board of Supervisors. All levels of severity are initially recommendations proposed by staff based on information provided by the various service providers. These recommended levels of severity should be taken as general indicators of declining resource availability.

The "action requirements" are not invoked in response to recommended levels of severity. If the Board of Supervisors determines that a particular resource situation is not being dealt with adequately, or that a failure to act could result in serious consequences, it sets in motion the certification process.

The certification process involves the completion of a Resource Capacity Study (RCS) which investigates the resource issue in more detail than the preliminary analysis which resulted in the "recommended" level of severity. The RCS is the subject of public hearings by the Planning Commission and the Board of Supervisors. If the Board of Supervisors certifies a level of severity, the appropriate “action requirements” are implemented.

The ASR considers the following services and measures of the adequacy of those services:

Service	Measure
Water Supply	Safe Yield/Extractions
Water Systems	Percent of Capacity
Sewer Systems	Percent of Capacity
Roads	Vehicle/Capacity
Schools	Enrollment/Capacity
Air Quality	State Standards

How is Information Gathered for this Report?

The information and data gathered for this ASR is received from the service providers. **This is a completely voluntary program**. Each July, the Public Works Department asks water suppliers throughout the county to report on water demand and supply for their jurisdiction. Staff will contact service providers who have not submitted the requested information within the requested timeframes. Other service providers such as wastewater system operators are contacted and sent standard forms to complete and return. Schools usually cannot report on the current year enrollment figures until October.

Detailed information, such as responses to the state-mandated 20% per capita water demand reductions, is usually provided directly by the service providers (see Cambria and Paso Robles for examples). As this reporting system is a voluntary program, service providers are not obligated to respond to requests for information, however most do. As a result, data gaps in the ASR may occur each year if information requested is not provided. The cooperation and participation of the service providers who do respond each year is greatly appreciated.

How are Population Forecasts Made?

Population forecasts in the ASR are derived from a 2009 population update of the 2000 census prepared by the San Luis Obispo Council of Governments (SLOCOG). The unincorporated community populations were estimated by allocating the total unincorporated population among all the communities and rural area based on past growth rates, issued building permits and estimated household size. Because many assumptions must be made in order to estimate population, the number is not exact. The 2010 Census results are being used to estimate the populations within the urban reserve lines of the unincorporated communities in collaboration with SLOCOG. Those population estimates will be used in next year's ASR.

Summary of Levels of Severity

Planning Area	Community	Water Supply	Water System	Sewer	Roads	Schools	Air Quality
South County	Avila Beach					III	
	Arroyo Grande				III	III	
	San Luis Obispo				III	III	
	Nipomo Mesa (NMWCA)	***III***				III	II
	Pismo Beach					III	
	Oceano					III	
	Grover Beach					III	
North County	Atascadero					III	II
	Paso Robles					III	II
	San Miguel	***III***					
	Santa Margarita		III				
	Shandon	***III***				III	
	Templeton	***I***			I	III	
	Heritage Ranch						
North Coast	Cambria	III				III	
	Cayucos						
	CSA10A		III				
	M.R. Mutual		II				
	P.R. Beach		II				
	Los Osos	***III***		III			
	Morro Bay						
	San Simeon	III	III			III	
Groundwater Basins	Cuyama Valley	III					
	Los Osos	***III***			III		
	Morro-Chorro	III					
	North Coast	III					
	Paso Robles Atascadero Sub-basin	***III*** ***I***					
	San Luis Creek	I					
	Nipomo Mesa Water Cons. Area	***III***					

Entries shown in ***bold/underline/italic*** indicate levels of severity that have been certified by the Board of Supervisors.

The RMS defines levels of severity for each resource. The criteria used to determine levels of severity for each resource are as follows:

Resource	Level of Severity I	Level of Severity II	Level of Severity III
Water Supply	When projected water demand over the next nine years equals or exceeds the estimated dependable supply.	When projected water demand over the next seven years equals or exceeds the estimated dependable supply.	When projected water demand equals or exceeds the estimated dependable supply.
Water System	When the water delivery system is projected to be operating at design capacity within seven years.	When the water delivery system is projected to be operating at design capacity within the next five years.	When the water delivery system reaches its design capacity.
Sewage	When projected peak flow equals the treatment plant design capacity within six years.	When projected peak flow equals the treatment plant design capacity within five years.	When projected peak flow equals or exceeds the treatment plant design capacity.
Sewage Collection System	When the projected flow in two years of any portion of the delivery system is 75% of its capacity.	When any portion of a sewage delivery system is operating at 75% of its capacity.	When peak flows reach 100% of capacity.
Roads	When traffic projections indicate that roadway level of service "D" will occur within five years.	When traffic projections indicate that roadway level of service "D" will occur within two years.	When calculation of exiting traffic flows indicate as roadway level of service "D"".
Schools	When enrollment projections reach school capacity within seven years.	When enrollment projections reach school capacity within five years.	When enrollment equals or exceeds school capacity.
Air Quality	See page I-7		

Roads

The ability of streets and roads to carry vehicular traffic depends upon several factors. The number of traffic lanes, surrounding terrain, existence of roadway shoulders, and number of other vehicles all affect the capacity of roads. The 2000 Highway Capacity Manual, published by the Transportation Research Board, sets standards for these and other factors which determine traffic "levels of service" (LOS). Levels of service ranging from level "A" to "F" are defined as follows:

LOS "A" Free flow: Unlimited freedom to maneuver and select desired speed;
LOS "B" Stable flow: Slight decline in freedom to maneuver;
LOS "C" Stable flow: Speed and maneuverability somewhat restricted;
LOS "D" Stable flow: Speed and maneuverability restricted. Small increases in volume cause operational problems;
LOS "E" Unstable flow: Speeds are low; freedom to maneuver is extremely difficult. Driver frustration is high during peak traffic periods;
LOS "F" Forced flow: Stoppages for long periods. Driver frustration is high at peak traffic periods.

U.S. Highway 101

In 2009, the Board of Supervisors directed staff to include in the ASR the condition of interchanges in the unincorporated communities along the U.S. Highway 101 corridor. The information is developed by the Public Works Department. This year, three of those interchanges were analyzed for needed future improvements: Tefft Street (Nipomo), San Luis Bay Drive (Avila Beach) and Main Street (Templeton). The results of these analyses may be found in the applicable community sections of this report. Additional interchanges will be evaluated in subsequent years.

Air Quality Criteria

Level of Severity I	Level of Severity II	Level of Severity III
Air monitoring shows periodic but infrequent violations of the state ozone standard, with no area of the county designated by the state as a non-attainment area.	Air monitoring shows one or more violations per year of the state ozone standard and the county, or a portion of it, has been designated by the state as a non-attainment for ozone.	Air monitoring at any county monitoring station shows a violation of the federal ozone standard on one or more days per year for three consecutive years.
Emissions in the planning area approach 75% of the designated threshold level and are projected to reach 100% within the next five years even with implementation of all emissions reduction strategies identified in the Clean Air Plan.	Emissions in the planning area reach 90% of the designated threshold and are projected to reach 100% within the next three years.	Emissions in the planning area equal or exceed a pollutant threshold level determined by the regional ozone modeling.
At least 50% of the available emissions reductions in the planning area have been utilized through the implementation of the emissions control measures approved through the CAP.	At least 75% of the available emissions reductions in the planning area have been utilized through implementation of emission control measures approved through the CAP.	All ozone control measures approved through the CAP have already been implemented in the planning area.

Resource and Infrastructure Needs

Our county's cities, unincorporated communities and rural areas face serious resource and costly infrastructure challenges. These challenges include protecting groundwater levels, securing new water supplies, constructing water distribution facilities, and funding improvements to major circulation facilities such as freeway interchanges. As people continue to be drawn to this area due to the appeal of rural character, quality of life and coastal areas, a more focused effort will be needed to address these resource and infrastructure issues.

INTRODUCTION

The community profiles in the following sections of this report describe the state of our communities and track their important infrastructure and resource needs. The primary resource and infrastructure needs relate to water supply (ground and surface water) and transportation. They include improvements such as pipelines, roads and freeway interchanges.

Some of our communities and rural areas have both long and short-term resource and infrastructure needs. In the case of water supply, additional supplies are potentially available to some areas, but are not being used to the fullest extent (e.g. unallocated State and Lake Nacimiento project water). Providing for resource and infrastructure needs will require both well considered policy choices and funding of important infrastructure.

Per Capita Water Demand

This year's ASR includes new information on water demand forecasts for each community to the years 2020, 2030 And 2035. Demand forecasts are based on "medium" growth projections for each community as published by SLOCOG.

Recently enacted legislation known as SBx7-7, requires urban water suppliers (water systems with 3,000 or more customers) to calculate and plan for a 20% reduction in per capita water use by the year 2020. We report the information supplied by each water provider when that information is available. In other cases, the department has used a simple method to calculate the 20% per capita reduction. A table is provided for each community where enough data exists to calculate the per capita reductions.

Recommendations

This ASR makes recommendations for actions in unincorporated communities. The ASR does not include recommended actions in the cities, as the County lacks jurisdiction in those areas.

New Recommendations

1. Provide maps of each service provider's area.

Ongoing Recommendations

Cayucos Water System

1. Establish LOS III for the CSA 10A water system with the following recommended actions:
   a. Design system improvements to address fire flow issues.
   b. Develop an infrastructure funding plan to implement system improvements.
   c. Perform a fire flow analysis.

Changes to RMS and Title 8 (Adopted 2008-2009 ASR)

1. The process to issue well permits should be modified. Well permits are issued by the Division of Environmental Health. Permits for new nonagricultural wells located in groundwater basins at LOS I, II or III (or basins whose safe yield is not known or wells in fractured formations) should be subject to the following requirements as amendments to Title 8 of the County Code:

   a. Semi-annual measurements by the Department of Public Works.
   b. Installation of flowmeters on all new wells (excluding replacement wells).
   c. Enroll in the Flood Control and Water Conservation District's (District) well-measurement program.
   d. Record water use and other information monthly and report semi-annually on a District-provided form.

2. Water use reporting of water by purveyors in support of the RMS is spotty at times. A lack of this type of basic information makes it difficult to analyze water use and to determine proper levels of severity for groundwater. The County should, either through its police powers or through the authority of the District, require all water purveyors (including mutual water companies) with over 10 connections to record water use and other information monthly and report semi-annually on a County-provided form.

3. Conditions should be established requiring wells associated with discretionary land use permits in groundwater basins in LOS I, II or III (or basins whose safe yield is not known or wells in fractured formations) to be a part of the District's water well level monitoring program.

4. The WRAC continues to be especially concerned with seawater intrusion in the coastal groundwater basins. The County should review the placement, effectiveness and possible expansion of the coastal sentry well program, especially in South County and Los Osos where seawater intrusion has already been documented. Investigation of seawater intrusion needs to be a high priority for the County, to the extent of their authority to address the specific situation.

5. Water planning and policy development requires close coordination between County departments. The WRAC recognizes that this coordination is akin to a three-legged stool: Public Works, Planning & Building, and Public Health (as the issuer of well permits). These three departments of the County need to increase their efforts to coordinate the County's approach to water issues. To begin coordination, the Health Dept-issued well permits should be subject to review for consistency with ASR action recommendations, Resource Capacity Studies, and County General Plan policies of the COSE.

6. The WRAC recognizes the efforts of vineyards to manage their water usage; however, recent efforts in North County have shown that we possess poor information on water use. In order to gather more data, voluntary well metering, monitoring and reporting should be encouraged.

7. The County should institute a three-phased approach to stream gauges:
    a. Continue gathering data from the stream gauges in place, refurbishing those in need of repair.
    b. Make a list of strategic places where stream gauge data would be effective and no gauges are in place.
    c. Make a phased-in schedule for funding and installing the needed gauges over a 3-5 year period.

8. The District shall continue to implement its Data Enhancement Plan with respect to well monitoring, and consider establishing an independent automated observation well program for groundwater basins with levels of severity (LOS) I, II, or III.

9. The report should include a map of the entire county showing the areas covered, and not covered, for water supply findings.

Nipomo Mesa Area

1. Continue the limitation on the number of dwelling units for the Nipomo Mesa area for the year 2009-10 through the County's Growth

Management Ordinance to 1.8% of the number of units existing in the area as of June 30, 2009.

2. At this time, a building moratorium is not considered an appropriate action for the Nipomo Mesa area. The Board adopted water conservation measures in the NMWCA in calendar year 2008 and will review the status of the programs in calendar year 2011. The Board may direct changes to the program once that review is completed in 2011.

3. Continue to implement water conservation measures adopted by the Board in 2008. Report back on the status of the programs in calendar year 2011.

4. New non-agricultural development in the NMWCA shall not result in a net increase in water use unless a supplemental water fee is in place.

5. Expand discussions with water purveyors in the NMWCA and include water rate structure, supplemental water supplies and expansion of small community water systems.

Santa Margarita

1. Maintain the LOS III for the water system.

2. Conduct a Resource Capacity Study (RCS) to help identify future water supply needs and water source options.

3. Monitor the progress of the development of the Santa Margarita Ranch. Phase-in water and road improvements that are needed for the proposed level of development on the ranch.

Cambria

1. Encourage continued implementation of water conservation measures in Cambria and San Simeon Acres.

2. Review new proposed landscaping plans for inclusion of water-efficient design elements.

3. Encourage voluntary lot mergers and other actions to support the CCSD buildout reduction program.

4. Encourage continued efforts to acquire alternative water supplies.

5. Facilitate and expedite, whenever possible, future permitting of CCSD water projects.

Los Osos

1. The LOCSD and other purveyors should consider adopting an aggressive water conservation program that would have the potential for achieving water savings significantly greater than the 8% conservation factor contained in the Water Management Plan. As water demand decreases, pumping from the lower aquifer should be commensurately reduced. Reducing pumping from the lower basin and ongoing water conservation and efficiency actions should be the focus of all purveyors and the Interloculatory Stipulated Judgment.

2. Water purveyors should pursue water recycling programs.

3. Water purveyors should implement all feasible conservation measures.

4. Water purveyors should periodically update estimates of agricultural and private domestic demand, as well as urban demand, to confirm water use estimates.

5. Water purveyors should implement changes in pumping patterns and monitor coastal wells to confirm that seawater intrusion is being slowed and, ultimately, halted.

6. Continue to implement water conservation programs adopted in 2008 and report the program status to the Board of Supervisors in calendar year 2011.

7. Continue to implement the recommendations of the report by Cleath Associates, upon which the LOCSD Water Management Plan is based.

San Simeon

1. Retain LOS III for water supply.

2. Continue the development moratorium.

3. Continue conservation activities.

Abbreviations

AFY: Acre Feet per Year
gpcd: gallons per capita per day
MGD: millions of gallons per day.

Countywide Map

The following county map includes the areas covered by the ASR such as cities and unincorporated communities and groundwater basins.

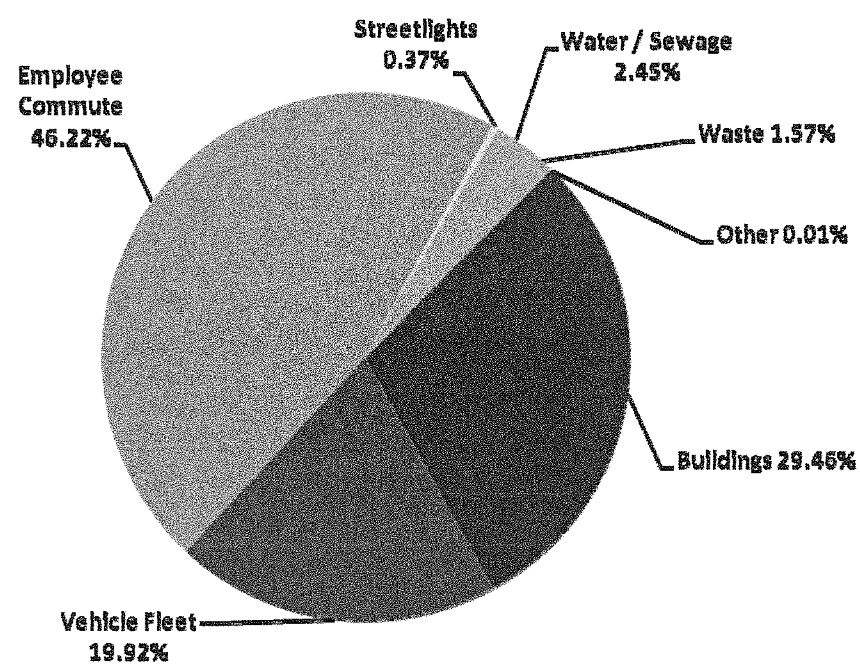
II. COUNTYWIDE

Greenhouse Gas Emissions

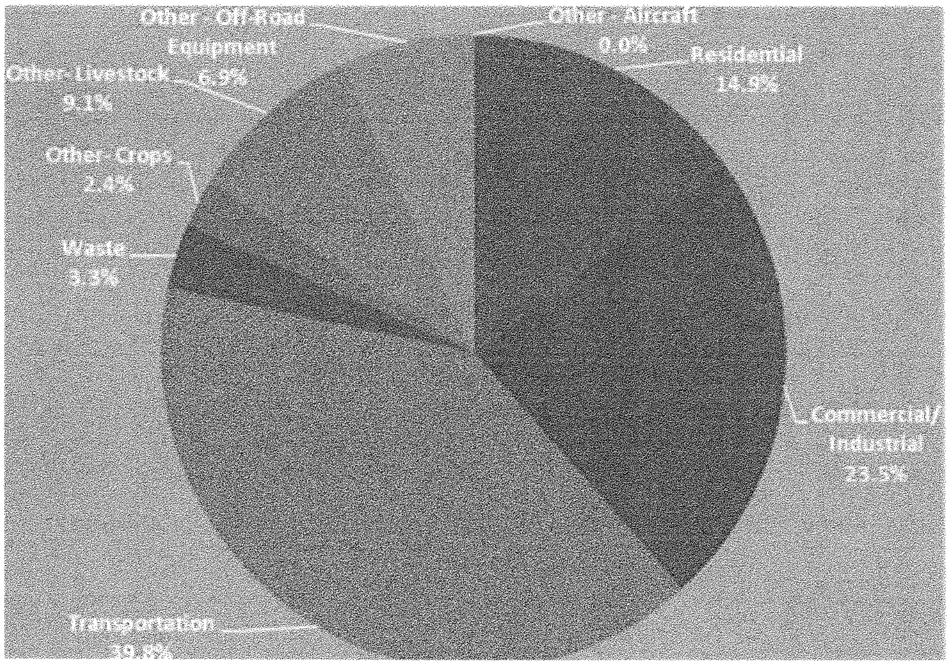
The topic of climate change is gaining a high priority among policy makers and residents alike. In July 2008, the County Board of Supervisors made a commitment to calculate the county's contribution to global climate change through the development of a Community-Wide and County Government Operations Baseline Greenhouse Gas Emissions (GHG) Inventory (Inventory). This Inventory identifies the major sources of greenhouse gas emissions within the county and provides a baseline against which future progress can be measured.

The GHG Inventory includes two components: a community-wide analysis and a County government operations analysis. It is important to note that the County government operations inventory is a subset of the community inventory, meaning that all County government operations emissions are included in the commercial/industrial, transportation, waste, or 'other' categories of the community-wide inventory. The County government operations inventory should not be added to the community analysis; rather it should be looked at as a slice of the complete picture.

County Operations Emissions



Community-wide Emissions



The County has prepared a draft Climate Action Plan (CAP) that will identify strategies to reduce the county's GHG emissions by 15% below the baseline year of 2006 by the year 2020. This goal is consistent with AB 32. The CAP is expected to be completed in 2011. It will include measures to reduce GHG emissions and will address the Inventory's emissions sectors. Once the CAP is completed and implementation commences, the County will conduct another GHG inventory for both Community and County Operations to gauge program success.

Rural/Urban Distribution of Building Permits

The split in distribution of building permits has averaged close to 60% urban and 40% rural over the last 10 years as shown in the following table. A shift to a lower proportion of rural development will become one of the measures of the success of the County's Strategic Growth principles and policies. The County should aim to meet the urban/rural distribution targets to be included in the San Luis Obispo Council of Government's Sustainable Communities Strategy (SCS) effort.

Distribution of Unincorporated Area Finaled Building Permits

Final Year	Rural	Urban	Total	% of Urban Dwelling Units
2000	277	493	770	64
2001	230	651	881	74
2002	366	521	887	59
2003	327	541	868	62
2004	437	683	1120	61
2005	372	661	1033	64
2006	385	521	906	58
2007	283	512	795	64
2008	304	422	726	58
2009	54	72	126	57
2010	93	144	237	61
Total 2000-2010	3128	5221	8349	62%

The Department will continue to work with San Luis Obispo Council of Governments (SLOCOG) in the coming year to coordinate possible policies for directing more future growth into existing communities with adequate resources through the County's Land Use and Circulation Element update and the Sustainable Communities Strategy (SCS) effort that is being completed by the SLOCOG staff.

Population

	2005	2008	2010	2015	2020	2025	2030	2035
Cities	144,546	148,303	151,064	155,230	160,250	165,040	171,040	177,100
Unincorporated	99,457	104,969	107,752	113,552	119,080	124,382	130,980	137,660
Countywide	259,574	269,336	273,446	284,846	295,394	305,486	318,084	330,824

Source: Dept. of Finance/SLOCOG

Vehicle Miles Traveled (VMT) and Vehicle Fuels Consumed (1990-2030)

Year	State Highway	Non-State Highway	Total VMT	Gasoline Gallons	Diesel Gallons	Total Gallons	VMT Gallons
1990	1482.00	698.93	2180.93				
1995	1557.01	767.08	2324.08				
2000	1734.24	896.26	2630.49	121.548	25.156	146.704	17.93
2005	1906.20	988.76	2894.96	134.711	27.932	162.643	17.80
2006	1955.34	983.73	2939.07	135.040	27.762	162.802	18.05
2007	1985.13	983.73	2968.86	134.938	23.957	158.896	18.68
2008	2000.54	991.36	2991.90	137.708	23.545	161.162	18.56
2010	2076.04	1028.78	3104.82	141.329	25.304	166.633	18.63
2015	2364.72	1171.83	3536.55	158.572	28.179	186.751	18.94
2020	2621.78	1299.22	3921.00	174.422	31.086	205.508	19.08
2025	2854.45	1414.52	4268.97	189.256	33.853	223.109	19.13
2030	3199.31	1585.41	4784.72	212.142	37.187	249.329	19.19

Source: Caltrans
Grayscale is forecasted VMT
Miles are in millions
Gallons are in millions

III. SOUTH COUNTY

The South County consists of four cities: Arroyo Grande, Grover Beach, Pismo Beach, and San Luis Obispo, and three unincorporated areas: Avila Beach, the Nipomo Area, and Oceano. Each resource is discussed by community, with the exception of regional resources that cross community boundaries and are shared among communities. Examples are schools, roads and wastewater treatment.

Contents

Regional Services

Avila Beach

Avila Beach is one of the 10 unincorporated urban areas in the County. It includes four geographic areas: the town, the adjacent Avila Valley, the San Luis Bay Estates development and Port San Luis. There appears to be adequate water and infrastructure for the small amount of future development planned for the area. With the recent completion of the San Luis Bay Drive Bridge, no major road improvements are needed in the future.

Population

The population within the urban reserve line has fluctuated in the past due to development moratoria and the soil and groundwater remediation project in the town of Avila Beach.

In addition, the San Luis Bay Estates development has been largely built out under the current general plan designations. Relatively small population increases are expected through 2035.

Avila Beach/Valley Population Estimate/Projections*							
2000	2005	2010	2015	2020	2025	2030	2035
833	933	1,058	1,139	1,185	1,230	1,285	1,335

*see population forecast note on page I-3

Water Supply

Water service in the Avila Valley area is a mix of the State Water Project, Lopez Water and groundwater. Water is provided by a community services district, several mutual water companies and private, individual wells. The Avila Beach Community Services District is the only water supplier that regularly participates in the County's voluntary water reporting program. The other suppliers have not participated in the program until this year.

SOUTH COUNTY

The Avila area's water suppliers and their sources of water are as follows:

Avila Beach Community Services District (CSD) serves the town area.
State Water: 100 acre-feet/year (AFY)
Lopez Water: 68.3 AFY

The District also has two wells that are currently inactive. These two wells have provided as much as 20 AFY in the past.

San Miguelito Mutual Water Co. primarily serves San Luis Bay Estates and some development along San Luis Creek.
State Water: 550 AFY

Bassi Ranch Mutual Water Co. serves the Bassi Ranch cluster development on the north side of San Luis Bay Drive.
No report was received from Bassi Ranch.

Avila Valley Mutual Water Co. serves Avila Valley Estates on the south side of San Luis Bay Drive.

State Water:	**21 AFY**
Lopez water:	**12 AFY**
	33 AFY

Port San Luis is located at the north end of Avila and receives water from County Service Area 12 (CSA 12). The CSA (which supplies water from Lopez Lake to south county communities) transfers up to 100 AFY of Lopez Reservoir water through its piping system to Port San Luis.

Other development in the Avila Valley relies on individual groundwater wells. Larger users include Avila Hot Springs, Sycamore Mineral Springs and agriculture.

The only water supplier in the area that regularly participates in the voluntary program to report water use is the Avila Beach CSD. The other water suppliers have not been part of the program until this year.

Water Use

Water use in Avila Beach has ranged from a low of 46 AFY in 2000-01 to 77 AFY in 2008-09, as shown in the following table.

Avila Beach CSD Total Water Use AFY (fiscal year)									
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2007-2008	2008-2009	2009-2010
54	46	47	52	49	48	51	76	77	73

Per capita water use in the Avila Valley ranges from a low of 144 gpcd in Avila Beach to 260 gpcd in Avila Valley. Due to Avila's small population, the water systems are not subject to the required 20% reduction in water use per capita by the year 2020. The following table uses a method developed by the California Department of Water Resources (DWR) to estimate 20% per capita reductions in water use.

Avila Beach Per Capita Water Use				
Year	Supplier	Population	Gallons Per Capita Per Day (GPCD)	Total AFY
July 2009-June 2010	Avila Beach CSD	450	144	72
	San Miguelito Mutual Water Company	1,200	153	206
	Avila Valley Mutual Water Company	112	260	33
2020	Avila Beach CSD	484	144	78
	San Miguelito Mutual Water Company	1,292	123	178
	Avila Valley Mutual Water Company	121	208	28
2025	Avila Beach CSD	503	144	81
	San Miguelito Mutual Water Company	1,341	123	184
	Avila Valley Mutual Water Company	125	208	29
2035	Avila Beach CSD	546	144	88
	San Miguelito Mutual Water Company	1,455	123	200
	Avila Valley Mutual Water Company	136	208	32

20% reduction in water use calculated using DWR Method 1

Level of Severity*:*
There is no level of severity for water supply.

Water Rates

Avila Beach CSD

Avila Beach CSD has tiered water rates.
Avg. Single Family Water Use: 3,740 gallons/Mo.
Avg. Single Family Water Bill: $39.50/Mo.

Avila Valley Mutual Water Co.

Avlla Valley Mutual Water Co. has a flat rate.
Ave. Single Family Water Use: 1.29 AFY (420,411 gallons)
Ave. Single Family Water Bill: $270.00/Mo.

Roads

Avila Beach Drive. The Level of Service on Avila Beach Drive is measured on off-peak days due to spikes in traffic volumes during limited summer weekends. Traffic volumes measured in May and September show that Avila Beach Drive operates at Level of Service (LOS) A and does not need widening. The recent construction of the new bridge at the intersection of Avila Beach Drive and San Luis Bay Drive should be the final road improvement in the Avila Valley area for some time.

Roadway	Location	LOS D Volume	PM Peak Hour Volume		
			2009	2011	2014
Avila Beach Drive	West of San Luis Bay Drive	1280	692	720	764

There is no level of severity.

Highway 101 Interchange	2010		2020	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
San Luis Bay Drive	5.4	A	7.1	A

Sewage

Facilities:

There are two wastewater providers in the Avila Beach area. The Avila Beach Community Services District (Avila Beach CSD) serves the town and the Port, and the San Miguelito Water Company serves the San Luis Bay Estates area. The eastern portion of the Avila Valley contains rural, hotel and recreational developments that are served by either the wastewater treatment providers or on-site septic systems. Existing development such as Avila Valley Estates (Tract 699) and the Avila Hot Springs should be served by one of the wastewater treatment providers due to on-site limitations.

Avila Beach CSD's Sphere of Influence includes all of Avila Valley east to the freeway and all of Avila Valley Estates that is currently served by San Miguelito Water Co. A single wastewater provider for the entire area including the town, San Luis Bay Estates, and the unsewered Avila Valley areas such as Avila Valley Estates may be preferable to the separate wastewater treatment providers and individual septic systems.

Operational Issues:
None reported.

Capacity:
According to the Avila Beach CSD, the wastewater treatment plant currently operates at 27% of capacity. Peak summer flows are at 56% of capacity. The District has recently seen an increase in waste strength that may affect design capacity. The District is studying whether or not the existing plant can handle the higher waste strength at the design flow capacity of 0.2 million gallons per day.

Level of Severity:
There is no level of severity.

Schools

Bellevue-Santa Fe Charter
Students attend Bellevue Santa Fe, a charter school located in the Avila Valley. In 2008-2009, 147 students attend this charter school, which has a maximum enrollment of 150 students. The Avila Valley area is part of the San Luis Coastal Unified School District. This enrollment is a level of severity III.

Parks

Avila Beach/Avila Valley Neighborhood and Community Parkland			
Park	Acres	2010 Acres Needed	2020 Acres Needed
Avila Park/Plaza	2.5 ac	3 acres	4 acres
See Canyon Park (Undeveloped)	8.7 ac		
Total:	11.2 ac		

Recommendations

The area has adequate water resources to reach buildout. The use of a single wastewater provider for the entire area should be studied and seriously considered.

LOS Summary Table (Avila Beach)

Avila Beach	Water Supply	Water System	Sewer	Roads	Schools	Air
Levels Of Severity					III	

Arroyo Grande

Arroyo Grande is one of the seven incorporated cities in the county and covers 5.45 square miles. It is located between prime agricultural lands and the Pacific Ocean. Arroyo Grande is a full-service city providing both water and sewer service..

The City's major infrastructure issues are building an interchange at El Campo Road and Highway 101, and bringing in additional water supplies to supplement water from Lopez Lake and groundwater.

Population

The City's estimated 2010 population is 17,140. Future population growth in the City will be constrained by infrastructure, water and land availability.

Arroyo Grande Population Estimates/Projections							
2000	2005	2010	2015	2020	2025	2030	2035
15,641	16,339	17,140	17,640	18,200	18,730	19,400	20,080

Water Supply

The City has agreements in place to draw up to 3,804 AFY from four water sources: two groundwater basins, Lopez Reservoir and through Oceano CSD. These sources are described below:

- 1,314 AFY is the City's share of groundwater extracted from the Arroyo Grande Plain, which is part of the Santa Maria Groundwater Basin. Extraction rights are shared by agreement with the City of Pismo Beach, the City of Grover Beach, and the Oceano Community Services District. This includes a 112 AFY allocation from an Agricultural Land Conversion Credit. As party to the Santa Maria Groundwater Basin litigation, Arroyo Grande may have its extraction rights decreased at a future date.
- 100 AFY groundwater is extracted from the Pismo Formation.
- 2,290 AFY from the Zone 3 Lopez Project is provided as a contractual supply to the City of Arroyo Grande. Environmental protection issues may call for

increased releases to Lopez Creek, thereby reducing the allotment available for Arroyo Grande and other cities.

- 100 AFY from Oceano Community Services District (Oceano CSD). The City of Arroyo Grande and Oceano CSD have entered into an interim water supply agreement, for delivery of up to 100 AFY of Oceano CSD water to the City. The City is currently using between 90% and 95% of its current supply allocation, and therefore is in need of temporary provisions to meet water supply needs. Oceano CSD will deliver up to 100 AFY of groundwater and/or State Water, at Oceano CSD's discretion. This temporary agreement ends in 2014.

In response to both long-term and short-term water supply concerns, the City has instituted mandatory water conservation measures. Numerous water conservation programs have been instituted (e.g., citywide toilet retrofit program, "cash for grass") is also underway to reduce water use.

Water Use

Water use in the City of Arroyo Grande has ranged from a low of 3,075 AFY in 2005-06 to 3,650 AFY in 2003-04.

Arroyo Grande Total Water Use AFY (fiscal year)										
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
3,334	3,365	3,407	3,467	3,650	3,381	3,075	3,245	3,475	3,333	3,097

Per capita water use is currently 162 gpcd. In compliance with State legislation, the City plans to reduce per capita water use by the amount below. The City expects buildout to occur in 2025 with yearly water use of 2,933 AFY.

Arroyo Grande Per Capita Water Use			
Year	Population	Per Capita Water Use (Gallons/Day)	Total AFY
July 2009-June 2010	17,080	162	3,097
2020	19,261	149	2,794
2025	20,224	149	2,933
2035	20,224	149	2,933

Information received from City of Arroyo Grande
City of Arroyo Grande expects buildout to occur in the year 2025

Water Rates

Avg. Single Family Water Use: 11,968 gallons/Mo.
Avg. Single Family Water Bill: $64.72/Mo.

Roads

Halcyon Road (South of Arroyo Grande Creek). The County Public Works Department is working on a project to install roundabouts at the Halcyon Road and Highway 1 intersections near the Arroyo Grande Creek. A plan to widen Halcyon Road to include a southbound climbing lane has not been approved. A LOS D will continue in the future without additional widening or the climbing lane.

Roadway	Location	LOS D Volume	PM Peak Hour Volume		
			2009	2011	2014
Halcyon Road	South of Arroyo Grande Creek	904	956	995	1056

*Shaded area indicates traffic volume levels exceed LOS D (PM Peak Volume Traffic).

This peak hour volume is a level of severity III.

Sewage

Facilities:
Wastewater treatment service is provided to the City by the South San Luis Obispo County Sanitation District. The City maintains the sewer lines and sends sewage to the wastewater treatment plant in Oceano. The community of Oceano and the City of Grover Beach also use this wastewater treatment plant. The treatment plant currently discharges treated effluent to the ocean through an ocean outfall line shared with the City of Pismo Beach.

Operational Issues:
None reported.

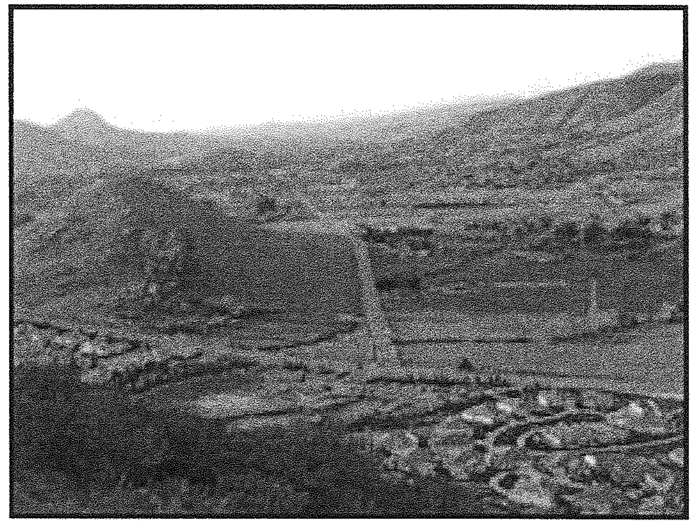
Capacity:
The South San Luis Obispo County Sanitary District treatment plant operates at 60% capacity.

Level of Severity:
There is no level of severity.

Schools

Arroyo Grande is part of the Lucia Mar School District. There are eight schools within the City: three elementary, two middle, and two high schools. Further information on the Lucia Mar School District is found near the end of the South County section of this report.

San Luis Obispo



San Luis Obispo is the County seat and the most populous of the seven cities in the county. The City's economy, as in most of the county, is bolstered by tourism and agricultural-based industries. The service industry is also a prominent part of its economy.

San Luis Obispo is a full-service city providing water, sewer and all other public services. The City lies within the San Luis Coastal Unified School District. The City has a diversified water supply that includes three surface water sources and reclaimed water from the City's wastewater treatment plant. Major interchange improvements on Highway 101 are needed at Los Osos Valley Road (LOVR) and Prado Road.

Population

As of January 2010, the City's population was approximately 42,540. The total population growth rate from the year 2000 to 2010 was approximately 1.3%. The year 2020 population estimate is 43,370. Buildout population is approximately 57,000.

City of SLO Population Projections							
2000	2005	2010	2015	2020	2025	2030	2035
42,317	42,763	42,540	42,590	43,370	44,120	45,060	46,000

Population figures based on SLOCOG 2009 and do not include "group quarters"

Water Supply

The City of San Luis Obispo has a diverse water supply. The City currently receives water from five sources: Salinas Reservoir (Santa Margarita Lake), Whale Rock Reservoir, Nacimiento Reservoir, local groundwater, and recycled water from the Water Reclamation Facility. The City has depended on imported supplies from Salinas Reservoir, located near the community of Santa Margarita, since 1944 and Whale Rock Reservoir, located near the community of Cayucos, since 1964. With the onset of the drought in 1986, resulting in decreasing surface water supplies, the City activated its groundwater sources in 1989. The City currently uses a small amount of groundwater (~2% of total) for potable purposes. Water deliveries to the City of San Luis Obispo from Nacimiento Reservoir began in January of 2011.

The Whale Rock Reservoir provides water to the City of San Luis Obispo, California Polytechnic State University, and the California Men's Colony as well as the town of Cayucos. The City staff work closely with staff from the other agencies relative to water planning issues.

The safe yield from the Salinas and Whale Rock reservoirs was adopted as 6,940 AFY in 2010, which takes into account losses due date in the yield from the two reservoirs due to siltation. The 2010 update to the City's Water Management Element of the General Plan also identified an additional 500 AFY of loss due to siltation for the next fifty years. The City will continue to utilize the limited amount of local groundwater, but due to limitations on its use (contamination, drought conditions, etc.), the City will not consider this supply in estimating available water resources to meet long-term community needs.

Water Use

Water use in the City of San Luis Obispo has ranged from a low of 6,217 AFY in 2001-02 to 6,988 in 2006-07 (which includes potable water delivered to Cal Poly from their Whale Rock Reservoir entitlement).

City of SLO Total Water Use AFY (fiscal year)										
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
6,835	6,610	6,217	6,429	6,851	6,448	6,984	6,988	6,420	6,322	6,459

The expected changes in per capita demand in the following table were developed by the City of San Luis Obispo.

San Luis Obispo Per Capita Water Use			
Year	Population	Gallons Per Capita Per Day (GPCD)	Total AFY
July 2009-June 2010	44,948	114	5,730
2020	49,650	117	6,507
2025	52,180	117	6,839
2035	54,850	117	7,188

Information received from City of San Luis Obispo.

Water Rates

Avg. Single Family Water Use: 6,732 gallons/Mo.
Avg. Single Family Water Bill: $52.13/Mo.

Roads

Los Osos Valley Road (West of Foothill). County Public Works recently completed the five year update of the Los Osos Circulation Study. Widening of Los Osos Valley Road to four lanes is included in the study; however, no funding is currently available for the project. Los Osos Valley Road is approaching LOS D volumes, 1437 in 2009. Level of Service D is reached at 1475 ADT. Volumes are projected to reach 1495 in 2011 and 1587 in 2014.

Tank Farm Road (West of State Route 227). This portion of Tank Farm Road will be widened to four lanes as described in the Airport Area Specific Plan. The project will increase the capacity of the roadway and the corridor is expected to operate at LOS C or better assuming existing volumes. The San Luis Obispo Fringe Road Improvement Fees would fund a portion of the widening. Proposed area development would implement portions of the widening project. Tank Farm Road surpasses LOS D PM Peak Hour Volumes, 1668 trips in 2009. The point at which a Level of Service D is reached is 1152. Volumes are projected to reach 1735 in 2011 and 1842 in 2014.

Roadway	Location	LOS D Volume	PM Peak Hour Volume		
			2009	2011	2014
Los Osos Valley Road	West of Foothill Boulevard	1475	1437	1495	1587
Tank Farm Road	West of State Route 227	1152	1668	1735	1842

*Shaded area indicates traffic volume levels that exceed LOS D (PM Peak Volume Traffic).

The peak hour volume for both roads is a level of severity III.

Sewage

Facilities:

The City's wastewater treatment plant produces tertiary-treated effluent. A water re-use project delivers this high quality water throughout the southern part of the City for landscaping purposes. As a result, a total of 1,000 acre-feet of reusable water will be available every year. The treatment plant also discharges clean water to San Luis Obispo Creek for habitat maintenance purposes.

Operational Issues:

None reported.

Capacity:

The City's Master Plan is almost complete. The Master Plan includes increasing the treatment's capacity to 5.5 MGD (million gallons per day).

The City's current plant capacity is 5.2 MGD. The plant is operating at 92.3% of its capacity.

San Luis Obispo Wastewater				
Current Daily Plant Capacity (mgd)	Peak Daily Flow (mgd)	Current Operational Percentage of Capacity	Expansion Plans	New Capacity After Expansion (mgd)
5.200	4.8	92.3%	Yes	5.600

Schools

San Luis Obispo is part of the San Luis Coastal Unified School District. For more details on this school district, see the discussion near the end of this South County section of the report.

Nipomo Area

The Nipomo Area consists of the unincorporated community of Nipomo, which is located both on the Nipomo Mesa and east of Highway 101, and the portion of the unincorporated Nipomo Mesa called "rural Arroyo Grande." This area has seen the highest growth of any unincorporated area of the county for the past decade.

The Nipomo Mesa Water Conservation Area (NMWCA-- please refer to the map at the end of this section on the Nipomo Area) is part of the Santa Maria Groundwater Basin and has been a key area considered in the Santa Maria Groundwater Basin adjudication lawsuit (please refer to the map at the end of this section on the Nipomo Mesa Water Conservation Area). The adjudication case has not yet been fully settled. The area will need additional supplies (referred to as "supplemental water") to bring the groundwater basin back into balance. The NMWCA is at a level of severity III for water supply.

The large number of water suppliers in the Nipomo Area creates difficulties for conserving water and obtaining supplemental water. Water suppliers include the public Nipomo Community Services District and private, for-profit companies such as Golden State Water Company and Rural Water Company. In addition there are many mutual water companies. Each operates under its own set of rules, is regulated by different entities, and has different purposes. Cooperative efforts among the larger suppliers occur through a technical group established as a result of the groundwater adjudication lawsuit.

Roads are a second infrastructure need in the area. A major Highway 101 interchange is being planned at the extension of Willow Road. In addition to the interchange, Willow Road will be extended from Pomeroy Road to Thompson Avenue. The construction of the first phase has begun. A future interchange may be considered at Southland Drive.

Wastewater service is provided by the Nipomo Community Services District within the Nipomo Urban Reserve Line. Other wastewater treatment providers include Nipomo CSD's plant in Blacklake Village, Rural Water Company's Cypress Ridge wastewater plant, and the Woodlands.

Population

The population of the Nipomo area has increased approximately 21% from the year 2000 to 2010. Population is expected to grow approximately 15% through the year 2020. Buildout is not expected to be reached by 2035.

Nipomo Population Projections*							
2000	2005	2010	2015	2020	2025	2030	2035
12,612	13,789	15,256	16,417	17,423	18,444	19,648	20,822

* See population forecast note on Page I-3

Water Supply

The Nipomo Community Services District (NCSD) provides water and wastewater service to approximately 25% of the Mesa area's population. The remainder of the area is served by other water providers, individual wells and individual septic systems.

The entire Nipomo area is dependent on groundwater. No surface water is brought to the Mesa from any of the five surface water projects that supply the county with potable water. This dependency on groundwater is problematic for this growing area.

Groundwater is used by all of the water purveyors in the NMWCA. These purveyors include the NCSD, the private, for-profit Golden State Water Company (GSW) and many private not-for-profit mutual water companies. The number of water purveyors and the lack of a clear regulatory structure is one of the water resource concerns within the NMWCA.

Total water use represents purveyor production from Golden State, Rural Water Co., and NCSD. Actual total water use was estimated by the NCSD to have exceeded 10,500 AF in 2007.

The NMWCA is at a certified level of severity III (LOS III) for water supply. The LOS III was first established in 2005 after preparation of a Resource Capacity Study (RCS). The RCS states: "Since current and projected pumping beneath the Nipomo Mesa exceeds inflow (natural recharge plus subsurface inflow), the Nipomo Mesa portion of the Santa Maria Groundwater Basin is currently in overdraft and projections of future demand indicate increasing overdraft." The Board of Supervisors certified the LOS III in 2007 and subsequently approved water conservation ordinances for the NMWCA.

The NCSD has taken the lead to bring new water resources to the NMWCA. The NCSD will construct a pipeline from Santa Maria to Nipomo. The pipeline will deliver approximately 2500 AFY to be shared by:

- Woodlands 415 AFY
- Golden State Water Co. 208 AFY
- Rural Water Co. 208 AFY
- Nipomo CSD 1,664 AFY

Water Use

The NCSD has taken a lead role in water efficiency and conservation measures. In approving the 2004 Sphere of Influence Update, LAFCO placed conditions on the NCSD's water service. One of the conditions was the institution of a water conservation program that would reduce per connection water use by 15%. The "core" activities that would be relied on heavily to reach this conservation goal are:

- A multi-tiered conservation rate structure.
- Public education and outreach measures
- Technical assistance (e.g. leak detection, water audits).

According to LAFCO, water conservation efforts since 2004 have reduced water use as follows:

Year	AF Pumped	Connections	AFY/Connection	AF/Connection Reduction (2004)	% Reduction since 2004
2004	2,908	3,751	0.78		
2005	2,794	3,879	0.72	-7%	-7%
2006	2,706	3,995	0.68	-6%	-12%
2007	2,856	4,077	0.70	+3%	-10%
2008	2,755	4,092	0.67	-4%	-13%
2009	2,698	4,138	0.65	-3%	-16%
2010	2,551	4,136	0.61	-6%	-22%

Water use in Golden State Water Company's service area has ranged from a low of 1,191 AFY in 2009-10 to 1,488 in 2003-04.

Golden State Water Co Total Water Use AFY (fiscal year)										
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
1338	1380	1415	1414	1488	1387	1289	1288	1365	1323	1191

The Nipomo CSD prepared the 20% per capita water use reduction for its service area. Golden State's 20% reduction uses DWR's Method 1.

Nipomo Per Capita Water Use				
Year	**Supplier**	**Population**	**Gallons Per Capita Per Day (GPCD)**	**Total AFY**
July 2009-June 2010	Nipomo CSD	10,815	211	2,550
	GSW	4,157	256	1,191
2020	Nipomo CSD	12,350	195	2,697
	GSW	4,747	205	1,088
2025	Nipomo CSD	13,227	168	2,495
	GSW	5,084	205	1,165
2035	Nipomo CSD	15,105	168	2,849
	GSW	5,806	205	1,331

Per capita water reduction was supplied by the NCSD
Golden State Water 20% per capita reduction uses DWR Method 1.

Level of Severity:
The NMWCA is at a level of severity III for water supply.

Water Suppliers

The following smaller water suppliers do not report water use. See the recommendations in the Introduction to expand reporting requirements.

Larger Suppliers	
Nipomo Community Services District	Rural Water Company
Golden State Water Company	Woodlands Water Company
Smaller Suppliers	
Arroyo Grande Mushroom Farm	Blacklake Canyon Water Supply
Callender Water Association	County Hills Estates
Greenheart Farms	Heritage Lane Mutual Water Co.
Hetrick Water Company	Ken Mar Gardens
La Mesa Water Company	Rancho Nipomo Water Company
Guadalupe Cooling	Clearwater Nursery
Cuyama Lane Water Company	Dana Elementary School
La Colonia Water Association	Laguna Negra Mutual Water Co.
Mesa Mutual Water Company	Rim Rock Water Company
Santa Maria Speedway	Speedling, Inc
True Water Supply	

Water Rates

Golden State:
Golden State has a 2-tier rate structure.
Avg. Single Family Water Use: 21,879 gallons/Mo.
Avg. Single Family Water Bill: $41.54/Mo.

Nipomo CSD:
Nipomo CSD has a 4-tier rate structure.
Avg. Single Family Water Use: 16,260 gallons/Mo.
Avg. Single Family Water Bill: $55.22/Mo.

Roads

Tefft Street. This is the only road in the Nipomo Area that is part of the RMS reporting system. The County Department of Public Works tracks the current service levels of roads and forecasts their future service levels. The current Tefft Street traffic volume (peak hour) is 1,728 average daily trips (ADT). The point at which a Level of Service D is reached is 2,815 ADT. Expected traffic level in 2014 is 1,908 ADT.

Roadway	Location	LOS D Volume	PM Peak Hour Volume		
			2009	2011	2014
Tefft Street	West of Mary Avenue	2815	1728	1798	1908

There is no level of severity.

Highway 101 Interchange	2010		2020	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Tefft Street	74.9	E	89.7	F

Sewage

Facilities:
The primary sewage treatment provider in the Nipomo Area is the Nipomo Community Services District. There are three other wastewater treatment plants operating in the Nipomo Area. The Woodlands development has a tertiary level plant that produces water used for golf course and median landscape irrigation. Another tertiary level plant is located at Cypress Ridge. Blacklake Village, which is within the NCSD, has a wastewater treatment plant, the treated effluent of which is used to irrigate the three fairways on the golf course. The rest of the Nipomo Area relies on septic systems for domestic waste disposal.

Operational Issues:
Operational issues at the NCSD treatment plant include occasional BOD (Biochemical Oxygen Demand) limit violations during settling pond maintenance. BOD is a basic measure of how well a plant is operating. A plant upgrade Master Plan is in preparation, with upgrade construction expected to begin in 2011.

Capacity:
According to the NCSD, the Southland wastewater treatment plant operates at approximately 63% of capacity.

Level of Severity:
There is no level of severity.

Schools

The Nipomo Area is served by the Lucia Mar School District. For more details about this school district, please see discussion near the end of this South County section of the report.

There are four schools located within the Nipomo Area: Dana Elementary, Dorothea Lang Elementary, Nipomo Elementary, and Nipomo High School.

Parks

Nipomo Neighborhood and Community Parks			
Park	**Acres**	**2010 Acres Needed**	**2020 Acres Needed**
Jack Ready Park (Undeveloped)	**30 ac**	**46 acres**	**52 acres**
Total:	**30 ac**		

Recommendations

1. Continue the limitation on the number of dwelling units for the Nipomo Mesa area for the year 2008-09 through the County's Growth Management Ordinance to 1.8% of the number of units existing in the area as of June 30, 2008.

2. At this time, a building moratorium is not considered an appropriate action for the Nipomo Mesa area. The Board adopted water conservation measures in the NMWCA in calendar year 2008 and will review the status of the programs in calendar year 2010. The Board may direct changes to the program once that review is completed in 2010.

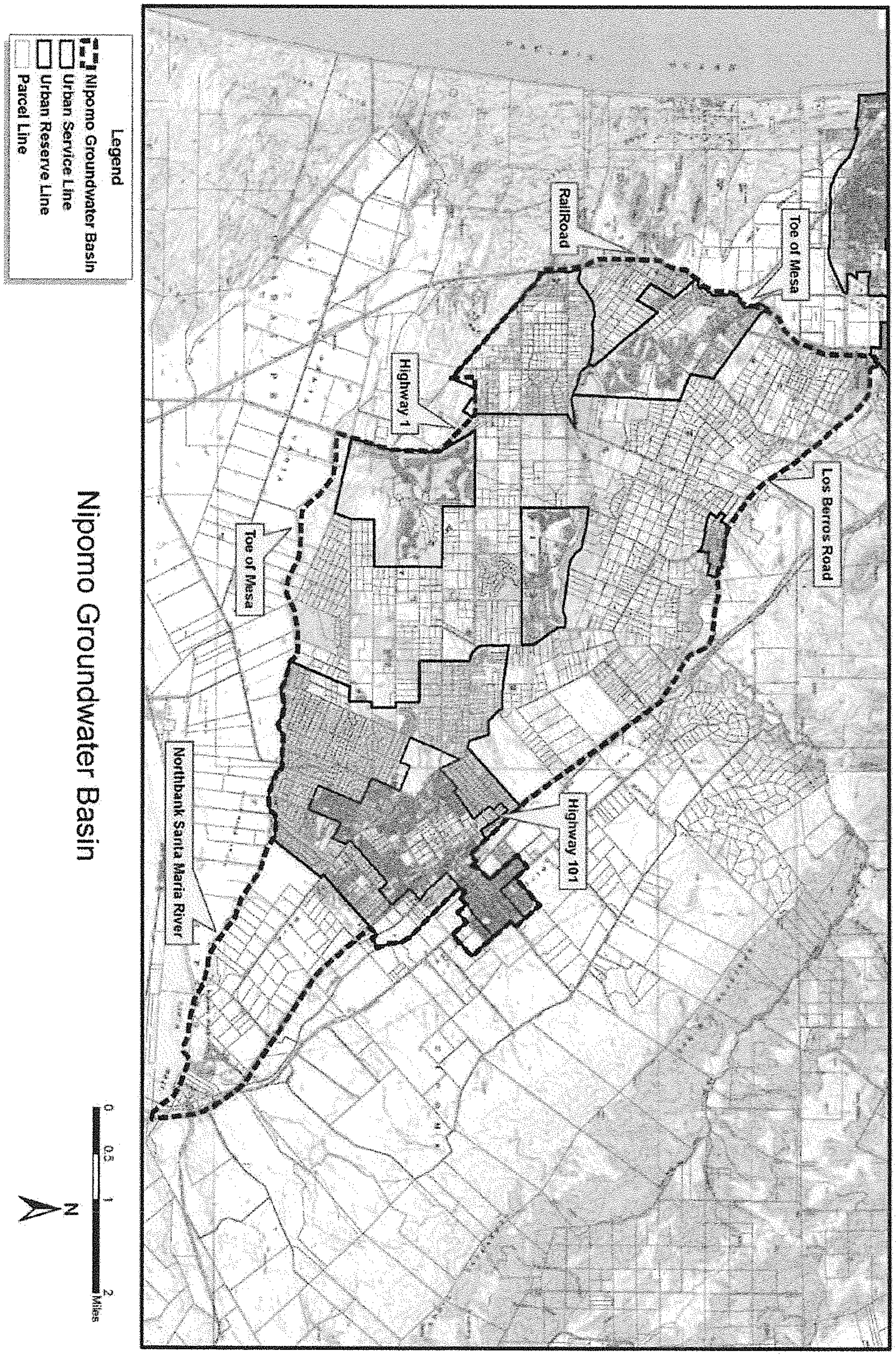
3. Continue to implement water conservation measures adopted by the Board in 2008. Report back on the status of the programs in calendar year 2010.

4. New non-agricultural development in the NMWCA shall not result in a net increase in water use unless a supplemental water fee is in place.

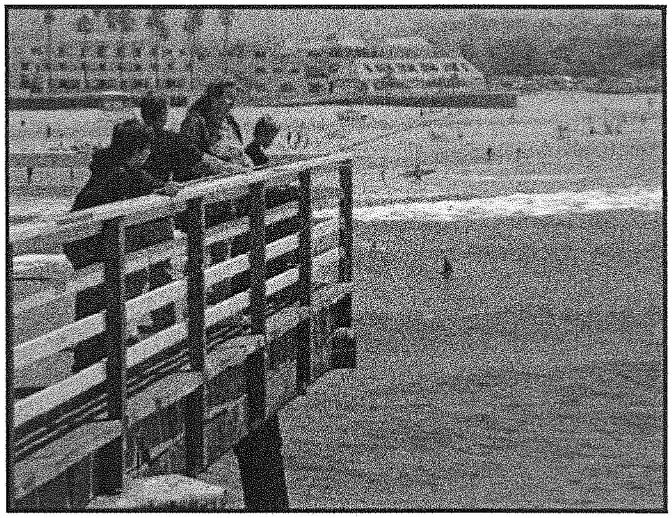
5. Expand discussions with water purveyors in the NMWCA and include water rate structure, supplemental water supplies and expansion of small community water systems.

LOS Summary Table (Nipomo Area)

Nipomo Area	Water Supply	Water System	Sewer	Roads	Schools	Air
Levels Of Severity	III				III	II


Nipomo Groundwater Basin
Legend
Nipomo Groundwater Basin
Urban Service Line
Urban Reserve Line
Parcel Line
RailRoad
Toe of Mesa
Highway 1
Los Berros Road
Toe of Mesa
Highway 101
Northbank Santa Maria River
0
0.5
1
2
Miles
N

Pismo Beach



Pismo Beach is one of the seven incorporated cities in the county, covering 3.6 square miles of land area. It is a full-service city providing water and sewer service. Public schools are provided by the Lucia Mar School District. The City seeks to annex lands adjacent to its southeastern border. Additional water resources are necessary for the annexations to proceed.

Population

The City's population grew at less than 1% per year from 2000 to 2010. Population growth in the future may be affected by proposed annexations on the southeast portion of the City. In addition to this permanent population, the City has a high number of visitor serving uses such as hotels and restaurants that are drawn by the City's coastal location. The visitors that are accommodated by these uses are not reflected in the City's population figures, but they affect water use, wastewater flows and traffic.

Pismo Beach Population Projections							
2000	2005	2010	2015	2020	2025	2030	2035
8,524	8,636	8,570	8,620	8,900	9,170	9,500	9,840

Water Supply

The City has a diverse water supply from Lopez Lake, State Water and groundwater. Additional water supplies will be needed for the proposed annexations in the southeast portion of the City.

Water Use

Water use in Pismo Beach has ranged from 2,247 AFY in 2003-04 to a low of 1,963 AFY in 2009-2010.

Pismo Beach Total Water Use AFY (fiscal year)									
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2007-2008	2008-2009	2009-2010
2,148	2,121	2,150	2,153	2,247	2,135	2,112	2,018	2,125	1,963

Per capita water use is currently 204 gpcd. Due to the City's small population, the water system is not subject to the required 20% reduction in water use per capita by the year 2020. The following table uses a method developed by DWR to estimate 20% per capita reductions in water use.

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Pismo Per Capita Water Use			
Year	Population	Gallons Per Capita Per Day (GPCD)	Total AFY
July 2009-June 2010	8,603	204	1,963
2020	8,900	173	1,728
2025	9,170	173	1,781
2035	9,840	173	1,911

20% reduction in water use calculated using DWR Method 1

Water Rates

Avg. Single Family Water Use: 11,220 gallons/Mo.
Avg. Single Family Water Bill: $52.50/Mo.

Roads

Levels of Service for roads in the Pismo Beach area are found at the end of the South County section of this report.

Sewage

Facilities:
The City operates its own wastewater collection and treatment system. A five-mile long pipeline brings treated wastewater to the South San Luis Obispo County Sanitary District treatment plant in Oceano. Effluent from both plants is then sent through an ocean outfall pipeline.

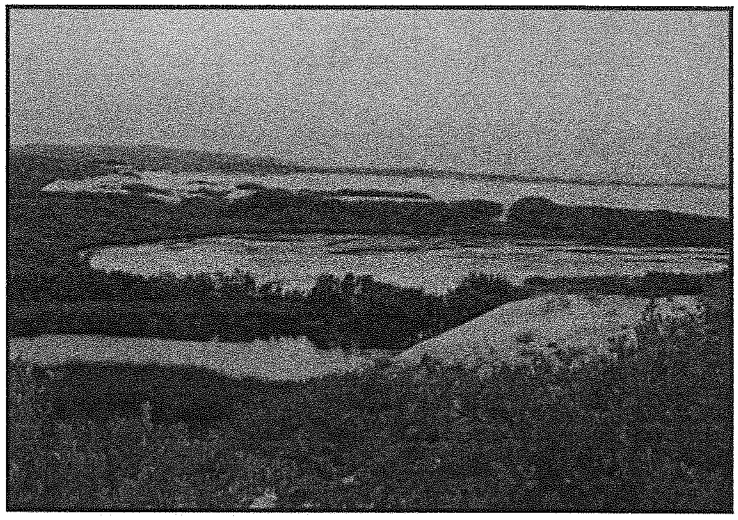
Operational Issues:
None reported.

Capacity:
The City of Pismo Beach Wastewater Treatment System operates at 23% of capacity.

Schools

The City is located within the Lucia Mar School District. Please see South County Schools at the end of the South County section of this report.

Oceano



This unincorporated community serves as the main entrance to the Nipomo-Oceano Dunes complex and the Oceano Dunes Off-Highway Vehicle Park, which draw a tremendous amount of visitors annually. Key services are provided by the Oceano Community Services District.

Population

New development in Oceano will continue to be chiefly infill of vacant or under-utilized parcels. The community is surrounded by incorporated cities, the Nipomo Dunes complex and agricultural lands.

Oceano Population Projection*							
2000	2005	2010	2015	2020	2025	2030	2035
7,244	7,614	8,098	8,377	8,462	8,470	8,504	8,918

*see population forecast note on page I-3

Water Supply

The community's water supply includes State Water, Lopez Lake and groundwater. The groundwater is part of the "Northern Cities" area of the Santa Maria Groundwater Basin. Neighboring cities are starting to plan for additional water supplies.

The community sources of water include a 303 AFY allotment from Lopez Lake and a 750 AFY allocation from the State Water Project. The community also uses groundwater.

Water Use

Water use in Oceano has ranged from 891 AFY in 2001-2002 to 968 AFY in 2009-2010.

Oceano Total Water Use AFY (fiscal year)										
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
911	926	891	895	951	Not provided	Not provided	Not provided	940	907	968

Water use totaled 968 AFY in 2009-2010 from:

- Lopez Lake
- State Water Project and
- Groundwater

There is not enough information available on water demand in Oceano to calculate a 20% reduction in per capita water demand by the year 2020.

Level of Severity:
There is no level of severity for water supply.

Water Rates

Current Rates: Oceano has a tiered rate based on consumption.

Avg. Single Family Water Use: 8,864 gallons/Mo.
Avg. Single Family Water Bill: $54.34/Mo.

Roads

Roads are discussed under South County Roads near the end of the South County section of this report.

Sewage

Facilities:
Wastewater treatment is provided by the South San Luis Obispo County Sanitary District. The service is shared with the cities of Grover Beach and Arroyo Grande.

Operational Issues:
None reported.

Capacity:
The South San Luis Obispo County Sanitary District operates at 60% capacity.

Level of Severity:
There is no level of severity.

Schools

The community lies within the Lucia Mar Unified School District, which is discussed under South County Schools near the end of the South County section of this report.

Parks

Oceano Neighborhood and Community Parks			
Park	Acres	2010 Acres Needed	2020 Acres Needed
Oceano Memorial Park	11.8 ac	24 acres	25 acres
Total:	11.8 ac		

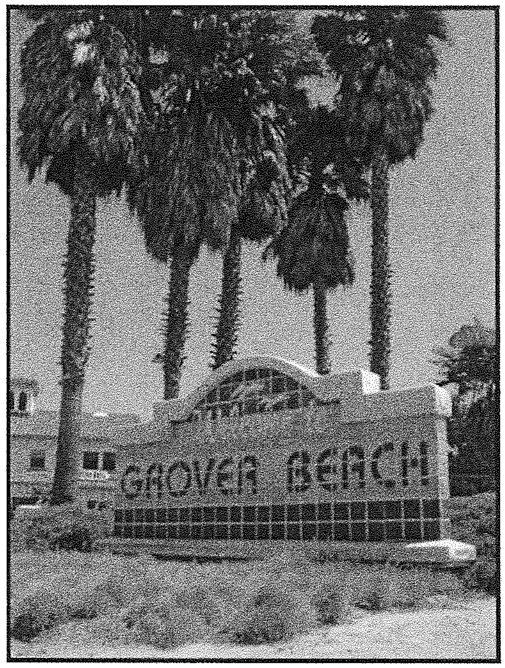
Recommendations

None.

LOS Summary Table (Oceano)

Oceano	Water Supply	Water System	Sewer	Roads	Schools	Air
Levels Of Severity					III	

Grover Beach



Grover Beach is one of the seven incorporated cities in the county and covers 2.25 square miles. The City provides water service to its residents and is served by the South San Luis Obispo County Sanitary District's wastewater treatment plant. The community's schools are in the Lucia Mar School District.

Population

The Department of Finance population data for Grover Beach shows a year 2000 population of 12,941, a year 2010 population of 13,070, and a year 2020 population of 13,390. The buildout population is estimated at 16,000 persons, which could be reached beyond the year 2035.

Grover Beach Population Estimates/Projections							
2000	2005	2010	2015	2020	2025	2030	2035
12,941	13,136	13,070	13,120	13,390	13,650	13,970	14,290

Water Supply

Grover Beach's water sources are similar to those of the City of Arroyo Grande. Approximately 1,200 AFY of the City's water is groundwater from the Arroyo Grande sub-basin of the Santa Maria groundwater basin. The other 800 AFY is the City's allotment of Lopez Lake water.

According to the City's Urban Water Management Plan (2005), an additional 800 AFY of water is needed for the City to reach its ultimate population.

The City uses its entire 800 acre-foot allocation from Lopez Lake. The City also has an "agreement" with other water users in the sub-basin allowing it to use a maximum of 1,428 AFY of groundwater.

The 2005 Urban Water Management Plan looks to a future desalination facility for its long-term supplemental water source. In the short-term, water transfers from other local water suppliers are planned.

Water Use

Water use in Grover Beach has ranged between 2,199 AFY in 2003-2004 to 1,851 AFY in 2009-2010.

Grover Beach Total Water Use AFY (fiscal year)										
1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
2,051	2,077	Not provided	2,027	2,199	Not provided	Not provided	Not provided	2,057	1,971	1,851

Due to the City's small population, the water system is not subject to the required 20% reduction in water use per capita by the year 2020. The following table uses a method developed by DWR to estimate 20% per capita reductions in water use:

Grover Beach Per Capita Water Use			
Year	Population	Gallons Per Capita Per Day (GPCD)	Total AFY
July 2009-June 2010	13,067	126	1,851
2020	13,390	101	1,517
2025	13,650	101	1,547
2035	14,290	101	1,619

20% reduction in water use calculated using DWR Method 1

Water Rates

Current Rates: Grover Beach reports a flat and tiered rate.
Avg. Single Family Water Use: 9,350 gallons/Mo.
Avg. Single Family Water Bill: $66.00/Mo.

Roads

Grover Beach does not include any of the roads in the County RMS system. Please refer to South County Roads near the end of the South County section of this report.

Sewage

Facilities:
Wastewater treatment service is provided to the City by the South San Luis Obispo County Sanitary District. The City maintains the sewer lines and sends sewage to the wastewater treatment plant in Oceano. The community of Oceano and the City of Arroyo Grande also use this wastewater treatment plant.

Operational Issues:
None reported.

Capacity:
The South San Luis Obispo County Sanitary District operates at 60% capacity.

Level of Severity:
There is no level of severity.

Schools

Grover Beach is part of the Lucia Mar School District. Two schools are located within the City:

- Grover Beach Elementary
- Grover Heights Elementary

Please refer to South County Schools near the end of the South County section of this report.

South County Water

Lopez Lake

The San Luis Obispo County Flood Control and Water Conservation District completed the Lopez Dam in 1968 to provide a reliable water supply for agricultural and municipal needs as well as flood protection for coastal communities. Lopez reservoir has a capacity of 49,388 AF. The lake covers 950 acres and has 22 miles of oak covered shoreline. Allocations for Lopez water are based on a percentage of the reservoir's safe yield of 8,730 AFY. Of that amount, 4,530 AFY are for pipeline deliveries and 4,200 AFY are reserved for downstream releases. The dam, terminal reservoir, treatment and conveyance facilities are a part of Flood Control Zone 3.

The agencies that contract for Lopez water in Zone 3 are the communities of Oceano, Grover Beach, Pismo Beach, Arroyo Grande, and County Service Area (CSA) 12 (including the Avila Beach area). Their allocations are shown in the table below.

Participant	Allocation (AFY)
City of Pismo Beach	896
Ocean CSD	303
City of Grover Beach	800
City of Arroyo Grande	2,290
CSA 12	241
TOTAL	4,530

According to the County Master Water Plan (MWP), there are two developments that could change both the amount of water available to contractors and the safe yield. The Arroyo Grande Habitat Conservation Plan, which is currently being developed, will likely require additional downstream releases. An interim downstream release schedule has reduced the amount of water available to municipalities. Changes in operation of the dam are being considered for reducing spills and optimizing future deliveries.

Whale Rock Reservoir

Whale Rock Reservoir is located on Old Creek Road approximately one half mile east of the community of Cayucos. The project was planned, designed, and constructed under the supervision of the State Department of Water Resources. Construction took place between October 1958 and April 1961. The reservoir is jointly owned by the City of San Luis Obispo, the California Men's Colony, and Cal Poly. These three agencies, with the addition of a representative from the Department of Water Resources, form the Whale Rock Commission which is responsible for operational policy and administration of the reservoir and related facilities. Day-to-day operation is provided by the City of San Luis Obispo. Water from the reservoir is allocated among three agencies as shown in the following table.

Participant	Allocation (AFY)
City of San Luis Obispo	22,383
Cal Poly	13,707
CMC	4,570
TOTAL	40,660

South County Schools

South County Schools Capacity, Enrollment, Recommended Levels of Severity (RLOS)					
District	**School**	**Capacity**	**Enrollment**	**Enrollment Capacity**	**LOS**
Lucia Mar Unified	Elementary	5,191	5,401	104.05%	III
	Middle School	1,810	1,676	92.60%	II
	High School	2,775	3,484	125.55%	III
San Luis Coastal Unified*	Elementary	4,133	3,409	82.48%	
	Middle School	1,550	1,071	69.10%	
	High School	2,670	2,493	93.37%	II

* Data was not received for 2010-2011. Last available data is from 2008-2009.

South County Air Quality

Ozone

Ozone is formed in the atmosphere as a byproduct of photochemical reactions between various reactive organic compounds (ROG), oxides of nitrogen (NO_x) and sunlight. The exhaust systems of cars and trucks produce about 50 percent of the county's ROG and NO_x emissions. Other sources include solvent use, petroleum processing, utility and industrial fuel combustion, pesticides and waste burning. The State hourly average ozone standard is 0.09 ppm. The State adopted an 8-hour average ozone standard of 0.07 ppm in 2006. Exceedances of the hourly ozone standard since 2000 are summarized in the following table:

Location	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Grover Beach	None	None	None	None	None	None	None	None	None	None
Nipomo	None	None	None	1	None	None	None	None	None	None
San Luis Obispo	None	None	None	None	None	None	None	None	1	None

PM10

Particulate matter less than ten microns (PM10) can be emitted directly from a source, and can also be formed in the atmosphere through chemical transformation of gaseous pollutants. Nitrogen oxides and reactive organic gases can both participate in these reactions to form secondary PM10 products. Re-entrained dust from vehicles driving on paved roads is the single largest source of PM10 in the county. Dust from unpaved roads is the county's second largest source of PM10. PM10 measurements throughout the South County have exceeded the State 24-hour average PM10 standard of 50 ug/m3 on numerous occasions in the past several years and the annual standard of 20 ug/m3. Exceedances of the 24-hour standard since 2000 are summarized in the following table.

Location	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Nipomo	None	3	2	4	2	None	1	2	1	2
San Luis Obispo	None	None	None	1	None	None	1	None	None	None
Mesa to Hwy 1	7	8	5	4	9	1	4	7	5	9
Ralcoa[1]	15	2	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hillview[2]	N/A	N/A	N/A	N/A	N/A	N/A	10	13	17	2

[1] Ralcoa PM10 monitoring terminated in 2002

[2] Hillview monitoring station was closed at the end of March, so the data for Hillview does not represent an entire year's worth of exceedances.

Particulate Matter Study

Historical ambient air monitoring on the Nipomo Mesa has documented atypical concentrations of airborne particulate matter compared to other areas of San Luis Obispo County and other coastal areas of California. These historical measurements show that the California health standard for PM10 (airborne particles with a mean aerodynamic diameter of 10 microns or less) is regularly exceeded in many locations on the Nipomo Mesa.

To better understand the extent and sources of these unusually high concentrations of particulate pollution on the Nipomo Mesa, the San Luis Obispo County Air Pollution Control District (SLO APCD) has conducted comprehensive air monitoring studies in that region. The Phase 1 South County Particulate Matter (PM) Study began in 2004 and utilized filter-based manual particulate samplers measuring both PM10 and PM2.5 concentrations at 6 monitoring sites located throughout the Mesa. Samples were collected over a one year period and analyzed for mass and elemental composition; meteorological measurements of wind speed and direction were also performed at numerous locations in the study area. Data from the Phase 1 study showed air quality on the Nipomo Mesa exceeds the state 24-hour PM10 health standard at one or more monitoring locations on over one quarter of the sample days.

Elemental analysis of PM2.5 filter samples demonstrated that on these high particulate days, the largest fraction of particles are composed of the wind blown crustal material containing silicon, iron, aluminum, and calcium. Meteorological data showed that high wind events entraining crustal particulate from the dune fields at the Oceano Dunes State Recreational Vehicle Area (SRVA) upwind of the Nipomo Mesa area and transporting them inland as the likely cause; data from a directional PM10 sampler on the Mesa that only operated on high wind days strongly supported this conclusion. Further analysis of Phase 1 study data was unable to provide a conclusive determination on whether off-road vehicle (OHV) activity in the SRVA played a role, either direct or indirect, in the particulate pollution observed on the Nipomo Mesa.

The Phase 1 Study Report was presented to the SLO APCD Board of Directors in March of 2007. The SLO APCD Board directed that a follow-up study (Phase 2) be conducted with the primary goal of determining if OHV activity on the SRVA played a role in the high particulate levels measured on the Nipomo Mesa; a secondary goal of the study was to determine what, if any, particulate impacts on the Mesa are due to fugitive dust from the petroleum coke piles at the ConocoPhillips Refinery complex.

The Phase 2 Study design involved three independent investigations using a broad array of technologies and measurement techniques to better understand the source(s) and activities responsible for the observed particulate pollution problem on the Nipomo Mesa. Determining the role of OHV activity on the SRVA was a key focus of the study, so it was important to conduct measurements and analyses both within and downwind of the dunes at the SRVA, as well within and downwind of "control site" dunes north and south of the SRVA where off road vehicles are not allowed, to evaluate the differences between them. PM and meteorological measurements downwind of the refinery coke piles and agricultural fields on the Mesa were also a necessary design element to determine potential contributions from those areas. Further, since the Phase 1 study showed that high PM concentrations on the Mesa occur primarily on high wind days, it was critical to ensure that study measurements captured the high wind events that typically occur during the early spring and late fall months. The field measurement phase of the study was conducted from January 2008 through March 2009.

The information in Phase 2, combined with the results of Phase I, lead to the following major findings:

- The airborne particulate matter predominantly impacting the region on high episode days does not originate from an offshore source.
- Neither the petroleum coke piles at the ConocoPhillips facility nor agricultural fields or activities in and around the area are a significant source of ambient PM on the Nipomo Mesa.
- The airborne particulate matter impacting the Nipomo Mesa on high episode days predominantly consists of fine sand material transported to the Mesa from upwind areas under high wind conditions.
- The primary source of high PM levels measured on the Nipomo Mesa is the open sand sheets in the dune areas of the coast.
- The open sand sheets subject to OHV activity on the SRVA emit significantly greater amounts of particulates than the undisturbed sand sheets at the study control sites under the same wind conditions.
- Vegetated dune areas do not emit wind blown particles; the control site dunes have significantly higher vegetation coverage than is present at the SRVA.

The major findings resulting from detailed analysis of the diverse and comprehensive data sets generated during the Phase 1 and Phase 2 South County PM Studies clearly lead to a definitive conclusion: OHV activity in the SRVA is a major contributing factor to the high PM concentrations observed on the Nipomo Mesa.

There are two potential mechanisms of OHV impact. The first is direct emissions from the vehicles themselves, which includes fuel combustion exhaust and/or dust raised by vehicles moving over the sand. Elemental analysis of study data shows combustion exhaust particles are not a significant component in the samples during high concentration periods. However, analysis of SRVA vehicle activity data does show a weak relationship between high PM10 concentrations

and high vehicle activity. This indicates a very small direct emissions impact from OHV activity caused by wind entrainment of dust plumes raised by vehicles moving across the open sand. While significant, the study data shows this is not the major factor responsible for the high PM levels downwind from the SRVA.
The second potential mechanism of impact from OHV activities involves indirect emission impacts. Offroad vehicle activity on the dunes is known to cause de-vegetation, destabilization of dune structure and destruction of the natural crust on the dune surface. All of these act to increase the ability of winds to entrain sand particles from the dunes and carry them to the Mesa, representing an indirect emissions impact from the vehicles. The data strongly suggests this is the primary cause of the high PM levels measured on the Nipomo Mesa during episode days.

On March 24, 2010, the SLO APCD Board accepted the South County Particulate Matter Study and its findings and directed the APCD staff to write a letter to inform State Parks of their action and to encourage State Parks' specific cooperation. In addition, direction was provided to the APCD staff to investigate the next action steps to be taken and to the APCD Counsel to investigate and report back on the APCD Board's regulatory authority on this matter.

At the May 19, 2010 APCD Board meeting, further action was taken to direct staff to enter into a Memorandum of Agreement between APCD, SLO County and State Parks to develop and implement a Particulate Matter Reduction Plan for the SRVA. Simultaneously APCD staff was also directed to proceed with the development of a Fugitive Dust Rule to address the South County PM issue. As this process is not completed yet, it is recommended that Planning and Building Department staff work with the APCD in the next year to determine the level of severity on the Nipomo Mesa.

Recommendation

The Resource Management System Air Quality criteria for determining levels of severity focus on emissions and violations of the state Ozone standard, but not on PM10 levels. The Department of Planning and Building will work with the SLO APCD to determine the appropriate level of severity for PM10.

South County Roads

The following roadways have been added to the level of severity list for the South County as they operate at LOS D volumes: Halcyon Rd, Los Osos Valley Rd, and Tank Farm Rd.

2010 RMS Levels of Service South County Roads

Roadway	Location	LOS D Volume	PM Peak Hour Volume		
			2009	2011	2014
Corbett Canyon Road	North of Arroyo Grande City Limits	909	258	268	285
Halcyon Road	North of Camino del Rey	898	423	440	467
Halcyon Road	South of Arroyo Grande Creek	904	**956**	**995**	**1056**
Lopez Drive	South of Orcutt Road	886	290	302	320
Los Berros Road	South of El Campo Road	978	578	601	638
Los Ranchos Road	West of State Route 227	968	583	607	644
O'Connor Way	North of Foothill Road	1084	165	172	182
Paso Robles Street	East of State Route 1	970	152	158	168
Price Canyon Road	South of State Route 227	995	805	838	889

*Shaded area indicates traffic volume levels exceed LOS D (PM Peak Volume Traffic).

Halcyon Road (South of Arroyo Grande Creek) – The road segment exceeds the LOS D PM Peak Hour Volume with 956 trips in 2009. LOS D is reached at 904 trips. Volumes are projected to increase in 2011 to 995 trips and in 2014 to 1056 trips. This Peak Hour Volume is a level of severity III.

Other Roads

Price Canyon Road: The County currently has two projects planned to widen Price Canyon Road. Widening of the bridges over West Corral de Piedra Creek and the Union Pacific Railroad crossing is scheduled to begin in 2011. A funding delay has resulted in the delay of the remaining roadway widening until 2015.

The County Public Works Department continues to actively pursue construction of the Willow Road Interchange to provide relief at the Tefft Street Interchange.

South County Parks

South County Regional Parks				
Park	**Natural Areas Acres**	**Acreage**	**Location**	**Provides**
Biddle Park	20	27	Arroyo Grande	47 acre park located on APN 047-080-038. Group and individual picnic areas, a gazebo, play equipment, two ball fields, restrooms, parking, and a trail.
El Chorro Park	450	40	San Luis Obispo	Two softball fields, group and individual picnicking, play equipment, camping, SLO Botanical Garden, parking, and restrooms.
Lopez Lake Recreation Area	4,076	200	Arroyo Grande	Camping, water slide, boating, water skiing, fishing, swimming, services (marina and gas), trails, and nature appreciation.