2009 Annual Monitoring Report
Northern Cities Management Area

Prepared for

The Northern Cities

By

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Annual Report
for the
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This report was prepared by the staff of Todd Engineers under the supervision of professionals whose signatures appear hereon. The findings or professional opinions were prepared in accordance with generally accepted professional engineering and geologic practice.

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1. Introduction

This Annual Report is a joint effort of the Northern Cities, namely the City of Arroyo Grande, City of Grover Beach, City of Pismo Beach and the Oceano Community Services District (CSD). The Northern Cities, County of San Luis Obispo, San Luis Obispo County Flood Control & Water Conservation District (FC&WCD) and local landowners have actively and cooperatively managed surface water and groundwater resources for more than 30 years, with the goal of preserving the long-term integrity of water supplies in the Northern Cities Management Area. This is recognized in the 2002 Settlement Agreement among the Northern Cities, Northern Landowners, and Other Parties, and in the 2005 Settlement Stipulation for the Santa Maria groundwater basin adjudication, which were adopted by the Superior Court of California, County of Santa Clara, in its Judgment After Trial, entered January 25, 2008 (herein "Judgment"). Figure 1 shows the four Northern Cities relative to the Santa Maria groundwater basin, as defined in the adjudication and as defined as the Santa Maria Valley groundwater basin (Basin 3-12) by the Department of Water Resources (DWR).

The Judgment approves the June 30, 2005 Stipulation agreed upon by numerous parties, including the Northern Cities, and orders the stipulating parties to comply with each and every term of the Stipulation. The 2002 Settlement Agreement is affirmed as part of the Judgment and its terms incorporated into the Stipulation, except for the provisions regarding continuing jurisdiction, groundwater monitoring, reporting, and the Technical Oversight Committee that are superseded by the respective provisions of the Stipulation.

As specified in the Judgment, the Northern Cities conducts groundwater monitoring in the Northern Cities Management Area. As shown in Figure 2, the Northern Cities Management Area (NCMA) represents the northernmost portion of the Santa Maria Groundwater Basin. Adjoining the NCMA to the southeast is the Nipomo Mesa Management Area (NMMA), while the Santa Maria Valley Management Area encompasses the remainder of the groundwater basin.

The Northern Cities Monitoring Program, in accordance with requirements of the Judgment, collects and analyzes data pertinent to water supply and demand, including:

- Land and water uses in the basin
- Sources of supply to meet those uses
- Groundwater conditions (including water levels and water quality).

The Monitoring Program obtains pertinent information on an annual basis through data requests to agencies, as-needed field work, and online research. Data are compiled into a comprehensive database, the Northern Cities Management Area Database (NCMA DB) and analyzed. Results of the data compilation and analysis for calendar year 2009 are documented and discussed in this Annual Report.

2. Climate Conditions

Climatological and hydrologic (stream flow) data for the NCMA are regularly compiled into the NCMA database. Appendix A includes climate data analyzed in this section.

2.1 Precipitation

Historical rainfall data have been compiled on a monthly basis for the NOAA Pismo Beach station for 1949 to 2005, while precipitation data from 2005 to present are available from a County-operated rain gage in Oceano. Figure 3 is a composite graph combining data from the two stations and illustrating annual rainfall totals from 1949 through 2009 (on a calendar year basis). Annual average rainfall for the NCMA is approximately 17 inches. The entire state has been in a prolonged drought for the past three years. During this drought, the precipitation conditions within the NCMA have been the second driest on record. The average three year precipitation for the period from 2007 through 2009 was only slightly less dry than the driest three year period on record, which ended in 1990.

The seasonal distribution of rainfall is illustrated in Figure 4 on a calendar year basis for both average conditions and for 2009. Most rainfall typically occurs from November through April; 2009 was marked by higher than normal rainfall in June, October, and December and below-normal rainfall in all other months.

2.2 Evapotranspiration

The California Irrigation Management Information System (CIMIS) has maintained weather stations in Nipomo and San Luis Obispo since 2006 and 1986, respectively, which record additional climatological data including temperature, wind speed, humidity, and evapotranspiration (ET). Monthly ET is shown in Figure 4 for 2009 and average conditions at the two stations.

3. Water Demand

In the NCMA, water demand falls into two major categories: urban demand and applied irrigation demand. Rural demand (including small community water systems, domestic, recreational and agriculture-related businesses) is relatively minor. Table 1 presents water demands for urban uses, applied irrigation, and rural uses. The values shown in Table 1 represent water demand in acre feet per year (AFY).

Table 1. Total Demand for Groundwater and Surface Water, AFY

Year	Arroyo Grande	Grover Beach	Pismo Beach	Oceano CSD	Total Urban	Applied Irrigation	Rural	Total Demand
2005	3,460	2,082	2,142	931	8,615	2,056	36	10,707
2006	3,425	2,025	2,121	882	8,453	2,397	36	10,886
2007	3,690	2,087	2,264	944	8,985	2,742	36	11,763
2008	3,579	2,051	2,208	933	8,771	2,742	36	11,549
2009	3,315	1,941	2,039	885	8,180	2,742	36	10,958

Notes:

Urban water demands based on actual production.
Demands for Arroyo Grande and Grover Beach include Soto Sports Complex and Mentone Park turf irrigation well production.
Evaluation of applied irrigation demand described in Section 3.2.
Evaluation of rural demand described in Section 3.3.

3.1 Urban Demand

Actual urban water demands are presented in Table 1 for each of the Northern Cities from 2005 through 2009. These demand values are based on reported Lopez Reservoir and State Water Project (SWP) purchases and groundwater production data, which have been entered into the NCMA database. These water demand values represent all water used within the entire service areas of the Northern Cities, including the portions of Arroyo Grande and Pismo Beach that extend beyond the NCMA (Figure 2). Urban demands include water delivered to municipal customers and all other water used by the respective municipal agency.

3.2 Applied Irrigation Demand

Applied irrigation is private water used for non domestic purposes. In the NCMA, applied irrigation demands are defined by agriculture and irrigated turf grass at schools and a golf course. Applied irrigation demand is estimated using crop type specific gross irrigation requirements by acre and land use data.

Gross irrigation requirements for the NCMA are from the San Luis Obispo County 1998 Water Master Plan Update. The County Water Master Plan Update includes low, average, and high estimates of irrigation demand by crop type for each of the Water Planning Areas (WPAs) in the County. The range in estimated irrigation demands is based upon climactic conditions and irrigation efficiency; double cropping is included for relevant crops. The Water Master Plan Update does not include gross irrigation requirements for turf grass. Gross irrigation requirements for pasture grass were applied to turf grass areas in the NCMA to estimate their applied irrigation demand, recognizing that pasture grass is the most similar to turf grass. The NCMA is in WPA 5; pertinent irrigation demands for each crop type and turf grass are presented in Table 2. The County Water Master Plan is currently being updated and future applied irrigation demand estimates will be informed by any updated information from the County.

Table 2. Gross Irrigation Requirement for WPA 5 by Crop Group

Crop Type	Low Annual Demand (AFY/acre)	Average Annual Demand (AFY/acre)	High Annual Demand (AFY/acre)
Alfalfa	2.5	2.9	3.3
Nursery	1.4	1.7	2.1
Pasture	2.6	3	3.5
Turf Grass	2.6	3	3.5
Citrus	1.3	1.6	1.9
Deciduous	2.6	2.9	3.2
Truck (vegetable)	1.2	1.4	1.6
Vineyard	0.9	1.1	1.4

Turf grass gross irrigation requirements are assumed to be the same as those for pature grass.

The areal extent of cultivated agricultural areas in the NCMA has been quantified using the 2007 land use survey by the San Luis Obispo County Agricultural Commission. The land use survey map provides information on acreage and type of crops in the area. The areas with irrigated turf grass have been identified by public works personnel within the Northern Cities. The acreages of these areas have been measured from publically available aerial photographs using GIS software tools.

There are about 1,600 acres of irrigated agriculture within the NCMA of which approximately four acres are in nursery crops, and the remainder is truck crops. There is a combined total of 44 acres of irrigated turf grass at the Oceano Elementary School, Arroyo Grande High School, Harloe Elementary School, and the Le Sage Riviera Golf Course.

For 2009, the annual precipitation and evapotranspiration have been compared to average conditions to determine if the year in question had a low, average, or high irrigation water demand. For this evaluation, average irrigation efficiencies are assumed for the NCMA. Therefore, the annual irrigation demand for each crop type is assumed to be dependant only on that year's precipitation and evapotranspiration. The range of demand estimates for all applied irrigation uses are as follows:

- Wet years: 2,056 AF/yr (2005 and 2006),
- Average years: 2,397 AF/yr (2004),
- Dry years: 2,742 AF/yr (2007, 2008, and 2009).

3.3 Rural Demand

Rural water demand includes small community water systems, domestic use, recreational use and agriculture-related business. Small community water systems using groundwater in the NCMA were identified initially through review of a list of water purveyors compiled in the 2005 San Luis Obispo County Integrated Regional Water Management Plan. These include the Halcyon Water System, Ken Mar Gardens, and Pacific Dunes RV Resort. The Halcyon Water System serves 35 homes in the community of Halcyon, while Ken Mar Gardens provides water supply to 48 mobile homes on South Halcyon Road. The Pacific Dunes RV Resort, with 215 RV sites, provides water supply to a largely transitory population and nearby riding stable. Two mobile home communities, Grande Mobile and Halcyon Estates, were previously served by private wells. However, these wells became unsuitable potable water sources because of high nitrates. In October 2003, the City of Arroyo Grande agreed to provide water to these two communities. In addition, about 25 homes and businesses have been identified through inspection of aerial photographs of rural areas within NCMA. Irrigation of schools and parks from privately operated wells is accounted for in the applied irrigation demand section. It is assumed that the number of private wells is negligible within the service areas of the four Northern Cities. The estimated rural water demand is shown in Table 3.

Table 3. Estimated Rural Water Demand

Groundwater User	No. of Units	Est. Water Demand, AFY per Unit	Est. Water Demand, AFY	Notes
Halcyon Water System	35	0.4	14	*1*
Ken Mar Gardens	48	0.12	6	*2*
Pacific Dunes RV Resort	215	0.03	6	*3*
Rural Users	25	0.4	10	*1*
Current Estimated Rural Use			36	

1 -Water demand/unit based on 2000 and 2005 Grover Beach water use per connection, 2005 UWMP.
2 - Water demand/unit from Patrick O'Reilly (former OCSD General Manager), 2008 for Grande Mobile and Halcyon Estates.
3 -Water demand/unit assumes 50% annual occupancy and 0.06 AFY per occupied site.

3.4 Changes in Water Demand

In general, urban water demand has gradually increased over time. However, in 2009 urban demand fell by seven percent when compared to 2008 (see Table 1). This change is attributed primarily to relatively cool weather in 2009 and the conservation activities implemented by the Northern Cities in response to the prolonged drought and threat of seawater intrusion. Agriculture is the primary source of demand in the applied irrigation category and agricultural acreage has decreased slightly in recent years, mostly reflecting infill in the urban area. Thus annual water demand for applied irrigation varies mostly with weather conditions. Acknowledging the variability due to weather conditions (see Table 1), applied irrigation water demand is not expected to change significantly, given the relative stability of applied irrigation acreage and cropping patterns in the NCMA south of Arroyo Grande Creek. Changes in rural demand have not been significant.

4. Water Supply Sources

This section summarizes NCMA water supply sources, presents groundwater conditions, and discusses threats to water supply.

4.1 Sources of Supply

The NCMA has three major sources of water supply: Lopez Reservoir deliveries, State Water Project deliveries, and groundwater.

4.1.1 Lopez Supply. All four municipalities in the NCMA receive water from Lopez Reservoir, which is operated by Zone 3 of the San Luis Obispo County Flood Control and Water Conservation District (FC&WCD). The safe yield of Lopez Reservoir is 8,730 AFY, which reflects the amount of sustainable water supply during a drought. Of this yield, 4,530 AFY have been apportioned by agreements to contractors, including each of the Northern Cities plus CSA 12 (in the Avila Beach area). Zone 3 entitlements are summarized in Table 4.

Table 4. Zone 3 Contractors

Contractor	Water Entitlement AFY
City of Arroyo Grande	2,290
City of Grover Beach	800
Oceano CSD	303
City of Pismo Beach	896
CSA 12 (not in NCMA)	241
Total	4,530
Downstream Releases	*4,200*
Safe Yield of Lopez Reservoir	*8,730*

Source: SLO County FC&WCD, Zone 3 UWMP 2005 Update.

The remaining 4,200 acre-feet per year of the safe yield is reserved for releases to maintain downstream flows in Arroyo Grande Creek and groundwater recharge. Management of the releases to avoid surface flow to the ocean has in the past resulted in an unreleased portion of the 4,200 AFY, which was periodically offered to the contractors as surplus water. Surplus water has been unavailable for a number of years as a result of releases for habitat conservation. During 2009 the total discharge from Lopez Reservoir was 8,603 AF, of which 4,599 was delivered to contractors and 4,004 was released downstream to maintain flow in Arroyo Grande Creek.

4.1.2 State Water Project. The City of Pismo Beach and Oceano CSD receive water from the California State Water Project (SWP). The San Luis Obispo County FC&WCD serves as the SWP contractor, providing the imported water to local retailers including Pismo Beach and Oceano. Pismo Beach has contractual rights (termed Table A allocation) to 1,240 AFY. Oceano has Table A contractual rights to 750 AFY.

In response to drought, the initial allocation to SWP contractors for 2009 was 15 percent of Table A amounts, which was subsequently increased to 40 percent in May. However, in 2009 San Luis Obispo County FC&WCD continued to request only 4,193 AFY of its entire 25,000 AF allocation and the entire request was approved. Unlike many water agencies across California that have received substantial cutbacks in SWP supply, Pismo Beach and Oceano were able to receive their full allocation.

4.1.3 Groundwater. Each of the Northern Cities has developed groundwater supply by means of respective well fields in the northern portion of the NCMA; NCMA groundwater also supplies applied irrigation and rural uses. Groundwater use in the NCMA is governed by the Judgment and the 2002 Settlement Agreement, which states that groundwater will continue to be allocated and independently managed by the Northern Parties (Northern Cities, NCMA overlying owners, San Luis Obispo County and FC&WCD). The Settlement Agreement initially allocates 57 percent of groundwater safe yield to agriculture and 43 percent to the cities and confirms that any increase or decrease in groundwater yield will be shared by the cities and landowners on a pro rata basis.

A groundwater safe yield value of 9,500 AFY was cited in the *2002 Groundwater Management Agreement* among the Northern Cities with subdivisions for applied irrigation (5,300 AFY), subsurface outflow to the ocean (200 AFY), and urban use (4,000 AFY). The Management Agreement's safe yield allotment for urban use was subdivided as follows:

City of Arroyo Grande	1,202 AFY
City of Grover Beach	1,198 AFY
City of Pismo Beach	700 AFY
Oceano Community Services District	900 AFY

The Management Agreement's subdivision for applied irrigation is higher than the actual applied irrigation groundwater use and the amount designated for subsurface outflow is unreasonably low. Maintenance of subsurface outflow is essential to preventing seawater intrusion. While the minimum subsurface outflow needed to prevent seawater intrusion is unknown, a regional outflow on the order of 3,000 AFY is a reasonable approximation.

The 2002 Settlement Agreement provides that the various urban parties' allocations can be increased when land within the corporate boundaries is converted from agricultural uses to urban uses, referred to as an agricultural conversion credit. Agricultural credits for the cities of Arroyo Grande and Grover Beach are 112 AFY and 209 AFY, respectively, for a total of 321 AFY.

4.1.4 Developed Water. As defined in the Stipulation, developed water includes Lopez supply (addressed in the previous section), return flows, and recharge from storm water percolation ponds.

With regard to storm water, the estimated recharge values should be updated and refined as new storm water ponds are installed and as additional information on pond size, infiltration rates, and tributary watershed area becomes available. In 2008, the cities of Arroyo Grande, Grover Beach, and Pismo Beach prepared storm water management plans; the cities currently are working with the Central Coast Regional Quality Control Board to address local storm water quality issues.

Grover Beach has implemented development standards that require on-site retention of storm water for new (and in some cases new and existing) impervious surface areas on a property undergoing development. Grover Beach also has modified its storm water system to direct additional flow into the Mentone storm water recharge basin. In addition, a flow meter was installed on one of the storm drains discharging to the Mentone basin; flow data currently are being compiled and analyzed.

Substantial efforts to increase storm water recharge (for example, construction of recharge basins) would augment the groundwater yield and could warrant provision of recharge credits among the Northern Cities. Recharge credits would be based on a mutually-accepted methodology to evaluate the recharge benefits. This would involve quantification of storm water runoff amounts, determination that the storm water otherwise would be lost to the groundwater basin, and documentation that the storm water would effectively recharge productive aquifers.

4.1.5 Water Use by Supply Source. Table 5 summarizes the water supplies currently available to the four Northern Cities in terms of Lopez entitlements, SWP allocations, groundwater allotments, and agricultural credits. Arroyo Grande has an active agreement to purchase 100 AFY of Oceano CSD supplies from groundwater or Lopez. The category of "Other Supplies" includes groundwater from beyond the NCMA.

Table 5. Available Urban Water Supplies

Urban Area	Lopez Entitlement, AFY	SWP Allocation, AFY	Groundwater Allotment, AFY	Ag Credit, AFY	Transfers, AFY	Other Supplies, AFY	Total, AFY
Arroyo Grande	2,290	0	1,202	112	100	90	3,794
Grover Beach	800	0	1,198	209	0	0	2,207
Pismo Beach	896	1,240	700	0	0	0	2,836
Oceano CSD	303	750	900	0	-100	0	1,853
Total	4,289	1,990	4,000	321	0	90	
							10,690

Figure 5 illustrates the water use by supply source for each Northern City since 1993. The graphs reveal changes in water supply availability and use over time, including the onset of SWP water in 1997 (see Oceano graph) and the unavailability of Lopez Reservoir surplus flows after 2001, which resulted in reduced and less variable Lopez water use after 2001.

Figure 6 shows total NCMA water use by supply source: Lopez, SWP, and groundwater. As shown, the full amount of Lopez supply (4,289 AFY) is currently used. In 2001 through 2003, SWP supplies (1,850 AFY) were used to the maximum extent. From 2004 to 2008, SWP use decreased to just over 1,100 AFY, mostly reflecting a partial shift by Pismo Beach from SWP to groundwater supply. This changed in 2009 when Pismo Beach increased SWP use and significantly decreased groundwater use in response to continuing drought and the threat of seawater intrusion (see Figure 5). In addition, Ocean CSD effectively ceased its groundwater use during the last three months of 2009.

In this figure, the groundwater use includes not only urban use, but also estimated applied irrigation and rural uses. As shown, total estimated groundwater use averages approximately 5,400 AFY and exceeded 6,000 AFY in 2007. With an estimated safe yield of 9,500 AFY, the remaining groundwater represents outflow to the ocean, an unknown but major portion of which is needed to repel seawater intrusion. In

2009, overall groundwater use was significantly reduced. Groundwater use was below average even though 2009 was the third year of a prolonged drought, as described in Section 2.

4.2 Groundwater Conditions

The NCMA groundwater monitoring program includes compilation of groundwater elevation data from San Luis Obispo County, Sentry Well water quality and groundwater elevation monitoring data from the network of sentry wells in the NCMA, and water quality data from the California Department of Public Health (DPH). These data have been collected for 2009 and incorporated into the NCMA Database along with historic data records. Analysis of these data is summarized below in accordance with the July 2008 *Northern Cities Monitoring Program*.

Groundwater Monitoring Network

Approximately 145 wells within the NCMA have been monitored by the County at some time in the past. The County currently monitors 38 wells on a semi-annual basis (April and October), including five sentry well clusters located along the coast. The County monitors more than 70 additional wells in southern San Luis Obispo County. Following the findings of the 2008 Annual Report, the Northern Cities initiated a quarterly sentry well monitoring program to supplement the County's semi-annual schedule.

A subset of key wells within the NCMA has been selected for preparation of hydrographs and evaluation of water level changes. Wells have been selected based on the following criteria:

- Part of the County's current monitoring program,
- Detailed location information available,
- Geographically well distributed,
- Long and relatively complete record.

It should be noted that many of the monitored wells are production wells that were not designed for monitoring purposes and are screened in various zones. Moreover, many of the wells are active production wells or located near active wells and thus are subject to incomplete recovery or drawdown effects that result in non-static (too low) measurements. As a result, the data cannot easily be identified as representing static groundwater levels in specific zones (e.g., unconfined or deep confined). Hence, the data should be considered as providing a general representation of groundwater conditions.

The sentry wells, shown on Figure 7, are a critical element of the groundwater monitoring network. The sentry wells provide an early warning system to identify and quantify the extent of seawater intrusion in the basin. Each well cluster has multiple wells allowing for the evaluation of groundwater elevation and quality from discrete depths. Also shown on Figure 7 is the Oceano Observation well, a dedicated monitor well cluster located just seaward of OCSD production wells 7 and 8. Figure 8 shows the depth and well names of the sentry well clusters and the Oceano Observation well in the NCMA. The wells are divided into three basic depth categories: shallow, intermediate, and deep. Since the initiation of the sentry well monitoring program four separate events have been completed; with one each in May, August, and October 2009 and one in January 2010. These monitoring events include collection of groundwater elevation data and water quality samples for laboratory analysis.

4.2.1 Groundwater Levels. Groundwater elevation data from the network of wells described above have been used to monitor annual effects of groundwater use, groundwater recharge, and the freshwater / seawater interface. Analysis of these groundwater elevation data has been assisted by the construction of groundwater surface contour maps, hydrographs, and an index of key sentry well levels over time. Groundwater elevation data are presented in Appendix B.

Contoured groundwater elevations for the October 2009 monitoring event are shown on Figure 9. Groundwater elevations were highest in the eastern portion of the NCMA near Arroyo Grande and Highway 101. Groundwater elevations were above mean sea level (msl) throughout the NCMA during the October monitoring event. This represents a significant recovery of groundwater elevations as compared to October 2008, when elevations were below sea level in the north-central portion of the NCMA with the deepest elevations at about negative ten feet msl.

The area below mean sea level in October 2008 extended to the coast, indicating a potential for seawater intrusion, as discussed in the 2008 Annual Report. This area, encompassing the municipal well fields, represented a relatively broad and shallow pumping trough exacerbated by drought conditions. While a pumping trough has persisted in the north-central portion of the NCMA, groundwater elevations were above sea level in October 2009.

Hydrographs for the key wells are shown on Figure 10, which illustrates long-term changes in groundwater levels in the NCMA, with two hydrographs from wells located just east of the NCMA in the Nipomo Mesa Management Area. The locations of the wells represented by the hydrographs are shown on the map in Figure 10. Noting that these hydrographs represent localized conditions at each well, most of the hydrographs indicate that groundwater elevations have historically varied over a range of about 20 feet above mean sea level and in the case of two inland wells, 40 feet.

The upper left and middle left portions of Figure 10 shows paired hydrographs for four wells located in the persistent pumping trough. (It should be noted that these wells are in active municipal well fields and true static conditions may be higher.) Although the data sets are incomplete, the hydrographs show that groundwater elevations in these wells have generally been above mean sea level. This indicates that the broad extent of the pumping trough is a relatively recent phenomenon. Most of the hydrographs in Figure 10 show that groundwater elevations have declined since 2006 (a wet year); this is a result of drought and increased pumping (see Figure 6).

Changes in groundwater elevations from October 2008 to October 2009 have been evaluated in the preparation of this report. Overall, water elevations rose by a few feet during water year 2009.

The sentry well clusters are the essential tool for tracking critical groundwater elevation changes at the coast. As shown by the hydrographs for the five sentry well clusters in Figure 11, the sentry wells provide a long history of groundwater elevations. In addition, groundwater elevations in these wells are monitored quarterly as part of the sentry well monitoring program. The deepest wells in the clusters adjacent to the NCMA urban area (wells 24B03, 30F03, and 30N02) are also screened at depths closely matching the screened depths of most local pumping wells. Hence, measured water elevations in these deepest wells reflect the net effect of changing groundwater recharge and discharge conditions in the most-used aquifer zone.

Averaging the groundwater elevations from these three wells provides a single, representative index for tracking the status of the basin, as illustrated by the hydrograph of the average deep sentry well elevations on Figure 12. The hydrograph on Figure 12 clearly shows that the past three years of drought have affected groundwater elevations in this highly-developed aquifer zone. In fact, the graph shows that this key index has been measured below sea level more frequently in the past three years than in any previous time since monitoring began. The graph also shows that this index has improved significantly since the 2008 Annual Report, when the Northern Cities first learned that groundwater elevations were below sea level.

4.2.2 Water Quality. Water quality is a key element of water supply; contaminants from seawater intrusion or anthropogenic sources can potentially impact the basin, reducing the available water supply. In the NCMA area, water quality data are available from dedicated monitoring wells and from water supply wells. In brief, there are four sentry well clusters that were originally installed by the California DWR along the coast. Each of these has two or three individual wells completed at different depths. In addition, the Oceano Observation well (located near Highway 1 in Oceano) was monitored along with the DWR sentry wells; it includes four individual wells completed at different depths. In addition to the monitoring wells, consolidated water quality information was compiled from the DPH for local municipal wells.

Sentry Wells

Since the last Annual Report, four separate sentry well monitoring events have occurred, with one each in May, August, and October 2009 and one in January 2010. During each event, the wells were all sampled in accordance with ASTM International Standard D4448-01. Water quality data from these events and available historical data are presented on Table 6. To identify water quality trends that may indicate seawater intrusion, time concentration plots and other geochemical plots have been prepared. The time concentration graphs for chloride and total dissolved solids (TDS) are shown on Figures 13 and 14.

There has been a wide variation in the spatial distribution of water quality during the year. The lateral and vertical spatial variation in water quality data could be due to a number of factors including: variable permeability of geologic materials, potential mixing with seawater, ion exchange in clay-rich units, and variability in surface recharge sources, such as Arroyo Grande and Meadow Creeks.

Sentry well cluster 32S/13E 30N is located west of Highway 1 in Oceano and includes three wells. The sentry well cluster is also situated in the middle of the pumping trough, and the deep and intermediate wells showed low groundwater levels for the past two years. This sentry well cluster indicates localized seawater intrusion affecting the deep zone (30N02) and, to a lesser extent, the middle zone (30N03) in 2009. Indicators of seawater at these two wells include increased concentrations of key constituents (especially chloride and total dissolved solids). The 2009 data from 30N02 and 30N03 show geochemical signatures of seawater intrusion on Schoeller geochemical plots. The most recent water quality data from this well cluster (January 2010) show a significant improvement in water quality in 30N02, including a reduction in the concentrations of seawater indicators and a return from the geochemical signature showing seawater intrusion to the historical signature of groundwater in 30N02.

These water quality changes indicate that the local interface/mixing zone between seawater and fresh groundwater is shifting. The location and inland extent of the seawater interface is not known beyond the fact that it was detected in 30N02; its greatest inland extent could be just to the north or south and/or in one or more vertical zones. The January 2010 sampling results suggest that the interface retreated seaward; however, the location of the interface/mixing zone is not known unless it intercepts a monitored well. Furthermore, the rapid retreat of the interface may be easily reversed if drought conditions return or pumping exceeds available groundwater supply. Ongoing sentry well monitoring is necessary to provide an early warning of future migration of the interface.

Sentry well cluster 32S/12E 24B has historically shown signs of possible seawater intrusion. This sentry well is located in the northwestern corner of the basin in Pismo Beach. The shallow well (24B01) shows a similar geochemical signature to that of seawater. However, water quality from this well historically has shown high sodium and chloride concentrations. These have been indicated by the California Department of Water Resources to be the result of "solution of residual marine and evaporative salts indigenous to the geologic environment in this part of the basin." As documented in Table 6, the water quality in 24B01 improved significantly between 1996 and 2009.

Sentry well cluster 32S/13E 30F is located in the pumping trough between the two sentry wells with relatively high chloride concentrations, and has shown low groundwater levels over the past two years. Nonetheless, the sentry well has not shown a significant change in water quality over time indicative of mixing with seawater. Water quality data from the southernmost sentry well in the NCMA, 12N/36W 36L, shows no indications of seawater intrusion.

Schoeller diagrams are geochemical tools that show the relative portions of major water quality constituents (in milliequivalents per liter or meq/L) to graphically differentiate water sources. Figure 15 is a Schoeller diagram illustrating the water quality in the DWR sentry wells for all of the 2009 plus the January 2010 monitoring events. As listed in the legend, each line of connected points illustrates the water quality signature from a specific well (e.g., 24B01) at a specific time (May 2009, abbreviated as 0509). The Schoeller diagram also shows the typical geochemical signature for seawater (in gray) and the signature for a groundwater basin water supply well (Grover Beach Well#1, labeled as GW Base). Most of the water quality samples plot on the lower portion of the diagram, similar in shape to the groundwater basin sample; these are combined within the shaded area. However, several samples from 32S/13E 30N showed signatures more similar to seawater in the spring, summer, and fall 2009. In January 2010, the signatures for the 30N wells, especially 30N02, changed again to a signature more similar to the groundwater base. The oscillation between the seawater and groundwater signatures indicates that the interface between seawater and fresh groundwater is shifting with probable mixing at this location.

The Oceano Observation well cluster has four wells; from shallow to deep, they are identified as green, blue, silver, and yellow (see Figures 7 and 8). As documented in Table 6, the Oceano observation wells have been sampled in every monitoring event since August 2009, but have not shown consistent water quality chemistry. In general, the two deep Oceano Observation wells show similar water quality to the rest of the groundwater basin with the exception of sulfate values that have fluctuated widely since monitoring began. Chloride concentrations have been slightly elevated and peaked in August 2009; however, the overall water quality character does not appear to indicate seawater intrusion. The water quality data from the two shallow Oceano Observation wells also have shown significant variation in several water quality parameters. As documented in Table 6, chloride concentrations from the blue well increased significantly in October 2009 and remained relatively high in January 2010. However, the water quality from this well does not show a clear seawater signature. Water quality data from the Oceano Observation wells show other anomalies potentially reflecting chemical reactions within the well itself; these warrant continued monitoring and geochemical analysis.

Municipal Wells

The Northern Cities and other community systems in the NCMA regularly submit water quality data to the DPH. These data are then uploaded to a state-wide water quality database. Data from DPH have been incorporated into the NCMA DB. Locations of the wells with water quality data are not released by DPH, but some well locations are available from the individual water systems.

Historically water quality concerns within the NCMA have focused on nitrate from agricultural and wastewater sources and on seawater intrusion. Known areas of high nitrate concentrations have been documented as far back as the 1950's. Water quality from all municipal wells generally meet all federal and state drinking water standards, agricultural and livestock watering standards, and the Regional Water Quality Control Board (RWQCB) Basin Plan Water Quality Objectives. There were limited exceedances of boron, cadmium, iron, manganese, nitrate, selenium, and total dissolved solids. In the case of manganese, nitrate, and selenium, wells have been sampled with additional frequency to provide more information. In all cases, the concentrations of these constituents are reduced through blending of water supplies such that water delivered to customers meets all drinking water standards.

Table 6: Northern Cities Sentry Well Water Quality Data Summary

Well	Construction	Top of Casing Elevation (feet MSL)	Date	Depth to Water (feet)	Groundwater Elevation (feet MSL)	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Bicarbonate (as CaCO3) (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Boron (mg/L)	Fluoride (mg/L)	Iodide (mg/L)	Manganese (mg/L)	Bromide (mg/L)	Alkalinity, Total (as CaCO3) (mg/L)	Carbonate (as CaCO3) (mg/L)	Hydroxide (as CaCO3) (mg/L)	Specific Conductance (umhos/cm)	Iron (mg/L)	Bromide / Chloride Ratio	Chloride / Bromide Ratio
32S/12E-24B01	Screened from 48-65' - 2-inch diameter	7.2																									
			1/27/2010	3.13	4.07	694	55	56.2	6.80	123	43.2	340	150	0.40	1.7	0.12	< 0.10	0.33	0.875	0.19	340	< 1.0	< 1.0	1,000	16.6	0.0035	289
			10/19/2009	2.28	4.92	766	140	121	16.7	111	52.4	303	150	0.25	2.8	0.0959	0.11	< 0.10	0.208	0.47	303	< 1.0	< 1.0	1,200	7.79	0.0034	298
			8/20/2009	3.25	3.95	705	94	86.8	11.7	116	35.6	286	150	0.21	2.7	NA	< 0.10	0.12	0.248	0.38	286	< 1.0	< 1.0	1,000	7.15	0.0040	247
			5/12/2009	3.58	3.62	695	100	82.1	13.2	108	45	288	150	NA	NA	NA	0.11	NA	0.66	0.29	288	< 1.0	< 1.0	1,100	23.9	0.0029	345
			3/26/1996	NA	NA	1,870	773	380	24.0	125	95	427	154	0.2	NA	0.27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/9/1976	NA	NA	1,706	667	400	16.2	94	95	474	159	0.4	NA	0.12	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/17/1966	NA	NA	1,700	652	406	20.0	95	83	440	175	1	NA	0.07	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/12E-24B02	Screened from 120-145' - 2-inch diameter	7.2																									
			1/27/2010	3.38	3.82	622	45	58.0	5.39	115	32.2	270	160	0.18	0.84	0.117	< 0.10	0.14	0.209	0.16	270	< 1.0	< 1.0	920	3.49	0.0036	281
			10/19/2009	2.26	4.94	600	49	59.1	5.12	112	30.1	281	160	< 0.10	0.98	0.0776	0.14	< 0.10	0.163	0.19	281	< 1.0	< 1.0	870	1.14	0.0039	258
			8/20/2009	4.09	3.11	630	49	63.5	5.85	128	30.1	288	150	< 0.10	0.98	NA	< 0.10	< 0.10	0.203	0.20	288	< 1.0	< 1.0	920	3.22	0.0041	245
			5/12/2009	4.74	2.46	622	82	67.5	6.33	114	34.5	282	150	NA	NA	NA	0.11	NA	0.252	0.24	282	< 1.0	< 1.0	990	6.76	0.0029	342
			3/26/1996	NA	NA	652	54	46	5	107	24	344	169	0.2	NA	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/9/1976	NA	NA	565	34	52	4	104	27	337	153	0.6	NA	0.02	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/17/1966	NA	NA	651	62	79	5	101	32	380	147	0	NA	0.05	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/12E-24B03	Screened from 270-435' - 2-inch diameter	7.2																									
			1/27/2010	0.94	6.26	672	48	56.4	5.40	119	43.4	336	150	< 0.10	1.4	0.101	< 0.10	0.15	0.140	0.15	336	< 1.0	< 1.0	1,000	5.18	0.0031	320
			10/19/2009	0.81	6.39	622	40	55.1	3.93	110	42.6	342	160	< 0.10	< 0.50	0.0613	< 0.10	0.13	0.0181	0.14	342	< 1.0	< 1.0	880	0.343	0.0035	286
			8/19/2009	4.18	3.02	680	47	54.9	5.21	128	43.4	337	150	< 0.10	2.2	NA	< 0.10	0.66	0.182	0.15	337	< 1.0	< 1.0	1,000	14.3	0.0032	313
			5/12/2009	3.18	4.02	645	44	53.2	4.53	108	41.8	332	140	NA	NA	NA	< 0.10	NA	0.124	0.16	332	< 1.0	< 1.0	1,000	5.9	0.0036	275
			3/26/1996	NA	NA	646	41	52	4.3	104	42	412	164	0.2	NA	0.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/9/1976	NA	NA	569	36	53	3.7	85	39	330	165	0	NA	0.06	0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/17/1966	NA	NA	670	79	74	5	103	36	345	158	1	NA	0	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/13E-30F01	Screened from 15- 30 and 40-55' - 1-inch diameter	17.3																									
			1/28/2010	12.73	4.57	725	140	99.9	2.70	76.4	35.8	214	170	1.6	0.84	0.120	< 0.10	< 0.10	0.112	0.56	214	< 1.0	< 1.0	1,200	0.640	0.0040	250
			10/19/2009	14.33	2.97	522	74	85.6	2.35	52.8	26.3	102	150	13	0.70	0.136	0.13	< 0.10	0.123	0.32	102	< 1.0	< 1.0	770	1.30	0.0043	231
			8/19/2009	14.34	2.96	648	92	98.9	3.84	63.1	31.9	113	190	10	0.56	NA	< 0.10	0.12	1.03	0.32	113	< 1.0	< 1.0	970	4.52	0.0035	288
			5/12/2009	12.38	4.92	792	110	108	2.89	80.2	39.9	136	280	NA	NA	NA	< 0.10	NA	0.0353	0.39	136	< 1.0	< 1.0	1,200	0.281	0.0035	282
32S/13E-30F02	Screened from 75-100' - 2-inch diameter	17.3																									
			1/28/2010	13.09	4.21	604	44	52.2	4.47	92.1	38.5	230	150	11	1.4	0.127	< 0.10	< 0.10	0.913	0.48	230	< 1.0	< 1.0	920	4.55	0.0109	92
			10/19/2009	14.36	2.94	566	49	49.5	2.80	88.3	37.6	240	140	11	1.0	0.0942	0.17	< 0.10	0.924	0.51	240	< 1.0	< 1.0	850	2.15	0.0104	96
			8/19/2009	14.81	2.49	614	49	51.8	3.19	87.3	36.8	225	130	11	2.00	NA	0.10	< 0.10	2.24	0.54	225	< 1.0	< 1.0	920	19.4	0.0110	91
			5/12/2009	14.34	2.96	514	54	48.7	3.26	81.1	34.9	206	120	NA	NA	NA	0.11	NA	1.87	0.53	206	< 1.0	< 1.0	890	3.23	0.0098	102
			3/27/1996	NA	NA	678	49	52	3.8	98	42	305	166	49	NA	0.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/9/1976	NA	NA	637	48	55	2.8	98	43	343	172	17.6	NA	0.1	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/20/1966	NA	NA	580	68	47	2	94	38	280	152	27	NA	0.08	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/13E-30F03	Screened from 305-372' - 2-inch diameter	17.3																									
			1/28/2010	10.98	6.32	656	40	43.1	3.91	112	47.2	310	180	< 0.20	2.8	0.0833	0.13	< 0.10	0.287	0.21	310	< 1.0	< 1.0	980	4.80	0.0053	190
			10/19/2009	14.18	3.12	626	48	43.3	3.14	108	46.2	308	170	< 0.10	1.8	0.0646	0.22	< 0.10	0.255	0.17	308	< 1.0	< 1.0	910	2.09	0.0035	282
			8/19/2009	20.23	-2.93	672	45	43.1	3.15	111	44.3	290	170	< 0.10	2.5	NA	0.14	< 0.10	0.468	0.19	290	< 1.0	< 1.0	980	18.5	0.0042	237
			5/12/2009	17.68	-0.38	678	49	44.8	3.32	109	42.9	276	180	NA	NA	NA	0.17	NA	0.146	0.18	276	< 1.0	< 1.0	960	1.16	0.0037	272
			3/27/1996	NA	NA	686	41	40	3.4	109	48	379	197	0.2	NA	0.13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/7/1976	NA	NA	616	43	41	2.6	96	49	333	190	0.4	NA	0.05	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/19/1966	NA	NA	642	69	49	4	109	40	321	182	1	NA	0.05	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/13E-30N01	Screened from 15-40' - 1-inch diameter	10.6																									
			1/26/2010	4.90	5.70	902	210	155	33.5	156	66.4	307	230	< 0.10	1.7	0.317	0.30	0.12	0.333	3.2	307	< 1.0	< 1.0	1,500	27.3	0.0152	65.625
			10/20/2009	6.53	4.07	828	200	159	34.3	118	59.8	238	230	< 0.10	1.3	0.241	0.38	< 0.10	0.157	3.2	238	< 1.0	< 1.0	1,300	5.33	0.0160	63
			8/20/2009	6.71	3.89	835	160	150	27.8	121	49.4	235	220	< 0.10	1.3	NA	0.37	0.12	0.228	2.9	235	< 1.0	< 1.0	1,400	15.9	0.0181	55
			5/11/2009	6.03	4.57	960	180	175	33.5	86.7	46.2	274	220	NA	NA	NA	0.36	NA	0.113	3.2	274	< 1.0	< 1.0	1,500	2.26	0.0178	56
32S/13E-30N03	Screened from 60-135' - 2-inch diameter	10.6																									
			1/26/2010	5.88	4.72	606	110	75.0	4.51	77.8	34.3	126	130	14	1.4	0.0654	0.15	< 0.10	0.0130	1.3	126	< 1.0	< 1.0	990	0.653	0.0118	85
			10/20/2009	6.56	4.04	806	180	93.3	25.5	92.3	41.5	162	150	9.7	2.2	0.107	0.26	< 0.10	0.245	1.4	162	< 1.0	< 1.0	1,200	0.344	0.0078	129
			8/20/2009	7.50	3.10	1,070	190	151	61.6	112	44.2	130	130	16	3.4	NA	0.20	< 0.10	0.151	1.6	130	< 1.0	< 1.0	1,700	1.93	0.0084	119
			5/12/2009	6.33	4.27	602	97	63.4	3.96	72.9	32.2	122	120	NA	NA	NA	0.22	NA	24	1.2	122	< 1.0	< 1.0	900	2.24	0.0124	81
			3/27/1996	NA	NA	624	70	62	4	78	35	150	161	106.8	NA	0.13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/7/1976	NA	NA	705	90	54	2.9	99	43	189	168	112.5	NA	0.08	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/21/1966	NA	NA	804	57	54	3	132	59	410	250	1	NA	0.08	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
32S/13E-30N02	Screened from 175-255' - 2-inch diameter	10.6																									
			1/26/2010	3.72	6.88	970	50	74.2	4.77	152	62.2	195	510	0.14	< 0.50	0.129	0.11	< 0.10	< 0.00500	0.16	195	< 1.0	< 1.0	1,300	< 0.100	0.0032	313
			10/20/2009	7.38	3.22	2,080	690	274	151	239	101.0	220	400	< 0.10	7.0	0.201	0.16	0.87	0.398	2.0	220	< 1.0	< 1.0	2,800	5.50	0.0029	345
			8/20/2009	11.94	-1.34	1,350	500	199	82.2	123	49.0	199	220	6.4	6.3	NA	0.23	0.14	0.339	2.8	199	< 1.0	< 1.0	2,100	4.91	0.0056	179
			5/11/2009	6.98	3.62	1,290	170	129	52	137	66.9	176	470	NA	NA	NA	0.18	NA	0.128	0.56	176	< 1.0	< 1.0	1,800	5.24	0.0033	304
			3/27/1996	NA	NA	1,050	50	71	5.5	145	60	243	516	0.9	NA	0.23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/7/1976	NA	NA	1,093	48	62	4.7	150	60	248	484	0	NA	0.13	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			1/21/1966	NA	NA	1,069	54	71	5	148	63	232	483	0	NA	0.12	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 6: Northern Cities Sentry Well Water Quality Data Summary

Well	Construction	Top of Casing Elevation (feet MSL)	Date	Depth to Water (feet)	Groundwater Elevation (feet MSL)	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Bicarbonate (as CaCO3) (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Boron (mg/L)	Fluoride (mg/L)	Iodide (mg/L)	Manganese (mg/L)	Bromide (mg/L)	Alkalinity, Total (as CaCO3) (mg/L)	Carbonate (as CaCO3) (mg/L)	Hydroxide (as CaCO3) (mg/L)	Specific Conductance (umhos/cm)	Iron (mg/L)	Bromide / Chloride Ratio	Chloride / Bromide Ratio
12N/36W-36L01	Screened from 227-237' - 2-inch diameter	22																									
			10/21/2009	17.72	4.28	856	38	72.0	4.64	131	48.2	192	420	0.49	0.84	0.150	0.12	< 0.10	0.0994	0.13	192	< 1.0	< 1.0	1,100	1.68	0.0034	292
			8/20/2009	19.16	2.84	890	39	78.0	4.21	138	48.1	184	390	0.49	0.56	NA	< 0.10	< 0.10	0.185	0.14	184	< 1.0	< 1.0	1,200	2.03	0.0036	279
			5/11/2009	17.68	4.32	832	63	83.8	4.88	111	45.4	204	330	NA	NA	NA	0.12	NA	0.551	0.22	204	< 1.0	< 1.0	1,200	4.02	0.0035	286
			3/26/1996	NA	NA	882	35	66	4.8	124	47	233	408	2	NA	0.24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/8/1976	NA	NA	936	38	72	3.5	130	48	223	423	0.6	NA	0.15	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12N/36W-36L02	Screened from 535-545' - 2-inch diameter	22																									
			10/21/2009	17.65	4.35	638	99	113	6.15	81.6	23.0	172	200	< 0.10	3.2	0.268	0.33	57	0.128	0.61	172	< 1.0	< 1.0	940	0.255	0.0062	162
			8/20/2009	19.15	2.85	785	100	131	6.66	89.8	36.6	290	190	< 0.10	3.8	NA	0.15	0.27	0.307	0.75	290	< 1.0	< 1.0	1,200	0.830	0.0075	133
			5/11/2009	14.38	7.62	775	120	132	7.24	84	39.7	294	180	NA	NA	NA	0.18	NA	0.426	0.78	294	< 1.0	< 1.0	1,300	0.958	0.0065	154
			3/26/1996	NA	NA	772	127	130	8.7	86	36	390	148	0.2	NA	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			6/8/1976	NA	NA	820	126	118	6.6	94	44	393	184	0	NA	NA	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oceano MW-Green	Screened from 110-130' - 3-inch diameter	35																									
			1/27/2010	43.71	-8.71	460	130	45.0	25.4	682	124	112	100	0.56	NA	< 0.0200	0.21	0.25	32.4	0.49	112.0	< 1.0	< 1.0	760	4,360	0.0038	265
			10/20/2009	29.20	5.80	362	92	39.6	2.92	19.2	45.1	76.8	110	< 0.10	< 0.50	0.0697	< 0.10	< 0.10	0.242	0.39	80.0	3.2	< 1.0	590	11.4	0.0042	236
			8/19/2009	24.55	10.45	420	160	48.4	3.37	49.9	20.4	17.6	54	< 0.10	1.1	NA	< 0.10	0.25	1.76	0.68	17.6	< 1.0	< 1.0	690	242	0.0043	235
			5/16/1983	15.8	19.2	665	35	40	NA	85	65	360	90	< 4	NA	NA	0.2	NA	0.01	NA	360	ND	ND	950	0.10	NA	NA
Oceano MW-Blue	Screened from 190-210' and 245-265' - 3-inch diameter	35																									
			1/27/2010	22.06	12.94	1,740	430	55.6	4.98	282	43.0	< 1.0	680	< 0.10	< 0.50	0.0819	0.14	0.41	9.41	2.0	< 1.0	< 1.0	< 1.0	2,300	170	0.0047	215
			10/20/2009	27.50	7.50	2,250	1000	19.5	2.40	487	22.5	5.0	410	< 0.10	0.98	0.0532	0.13	< 0.10	13.1	4.5	5.0	< 1.0	< 1.0	3,100	236	0.0045	222
			8/19/2009	24.65	10.35	322	150	93.2	16.7	23.9	12.1	3.0	4.0	< 0.10	1.3	NA	0.19	0.5	0.7	0.74	23.0	20.0	< 1.0	640	153	0.0049	203
			5/16/1983	13.3	21.7	840	80	90	NA	100	50	250	160.0	< 4	NA	ND	0.2	NA	0.14	NA	250.0	ND	ND	1,200	0.10	NA	NA
Oceano MW-Silver	Screened from 395-435' and 470-510' - 3-inch diameter	35																									
			1/27/2010	21.05	13.95	496	71	92.2	10.6	22.9	39.1	13.0	230	<0.10	< 0.50	0.323	< 0.10	0.20	0.604	0.29	51.0	38.0	< 1.0	780	54.4	0.0041	245
			10/20/2009	27.52	7.48	564	71	80.8	8.63	33.2	49.8	49.6	310	<0.10	< 0.50	0.148	< 0.10	< 0.10	0.337	0.32	64.0	14.4	< 1.0	850	20.0	0.0045	222
			8/19/2009	29.34	5.66	522	180	148	71.6	95.2	8.42	30.0	3.5	<0.10	1.7	NA	0.24	0.52	2.36	0.76	170	140	< 1.0	1,000	278	0.0042	237
			5/16/1983	13.5	21.5	630	40	40	NA	90	50	330	80	< 4	NA	NA	0.1	NA	0.02	NA	330	ND	ND	900	0.05	NA	NA
Oceano MW-Yellow	Screened from 625-645' - 3-inch diameter	35																									
			1/27/2010	20.58	14.42	498	89	79.6	10.2	15.6	38.0	31.0	180	< 0.10	0.56	0.132	< 0.10	0.19	0.283	0.38	51.0	20.0	< 1.0	810	23.6	0.0043	234
			10/20/2009	25.80	9.20	446	100	97.1	12.8	16.4	37.9	26.6	180	< 0.10	0.56	0.168	0.15	< 0.10	0.18	0.42	42.6	16.0	< 1.0	760	18.9	0.0042	238
			8/19/2009	31.04	3.96	426	160	101	18.9	93.2	29.1	64.4	36	< 0.10	0.98	NA	0.16	0.31	5.49	0.60	84.4	20	< 1.0	790	682	0.0038	267
			5/16/1983	14.3	20.7	770	60	70	NA	90	70	330	120	9	NA	NA	0.1	NA	0.02	NA	330	ND	ND	1,100	0.24	NA	NA

4.3 Threats to Water Supply

Threats to NCMA water supply are State-wide and local. State-wide threats include State-wide drought, climate change, and Sacramento-San Joaquin Delta issues that affect the amount and reliability of SWP deliveries. Local threats to NCMA water supply similarly include drought and climate change that affect the amount and reliability of Lopez and local groundwater supply. There is a threat of seawater intrusion if adequate preventive measures are not taken, as discussed in Section 4.2.2 above and Section 4.3.3 below.

4.3.1 Threats to SWP Supply. California has experienced below-average precipitation and runoff since autumn 2006. State-wide runoff in 2007 and 2008 amounted to only 53 and 60 percent of average, respectively, and runoff in 2009 was only slightly better at 85 percent. As a result, storage in SWP reservoirs has been reduced. In response, the Department of Water Resources has continued to limit its SWP allocations to contractors. In addition to drought conditions, SWP pumping capacity was reduced as the result of a May 2007 federal court ruling to protect Delta smelt. The threat to local SWP users—Oceano and Pismo Beach—has not materialized to date, as San Luis Obispo County's allocation continues to be approved in full. Nonetheless, in the future, the Delta's fragile ecosystem, uncertain precipitation patterns and reduced snowmelt will further reduce California's water supply reliability with potential ramifications for Oceano and Pismo Beach.

4.3.2 Seawater Intrusion. The NCMA is underlain by a coastal aquifer system that slopes gently offshore and extends for many miles under the ocean, with each aquifer zone including an interface between freshwater and seawater. Under natural and historical conditions, there has been a net outflow of freshwater from the groundwater basin to the ocean that keeps the interface from moving onshore. The existence of a net outflow is indicated by onshore groundwater elevations that are above mean sea level. To prevent seawater intrusion, maintenance of coastal groundwater elevations above sea level is needed along the length of the groundwater basin's coastline and in each vertical aquifer zone.

The 2008 Annual Report documented groundwater elevations that were below sea level in a broad pumping trough that extended from the north-central portion of the NCMA and included a portion of the coast. Hydrographs for NCMA sentry wells showed that coastal groundwater elevations had been sustained at relatively low levels for two years. Such sustained low levels had not occurred previously in the historical record and reflected the combined effect of drought and long-term, basin-wide increases in groundwater pumping. The low coastal groundwater levels indicated a potential for seawater intrusion that was locally manifested in sentry wells 32S/13E N02 and N03 in 2009.

As documented in Section 4.2.1 of this report, groundwater elevations in October 2009 showed a significant recovery of groundwater elevations relative to October 2008. In addition, groundwater quality in the sentry wells N02 and N03 improved as of January 2010, including a reduction in the concentrations of seawater indicators. The water quality changes in 2009 and early 2010 indicate the following:

- The monitoring of the sentry wells, notably 32S/13E 30N, provides an early warning of seawater intrusion. This well cluster may be relatively sensitive to seawater intrusion because of its location near Arroyo Grande Creek and the more permeable sediments deposited by the ancestral creek.

- The seawater/groundwater interface was detected onshore at one site in 2009; it had intercepted the middle and deep aquifer zones monitored by sentry wells N02 and N03. Seawater may have intruded other localized aquifer zones along the coast without being detected in the NCMA sentry wells. This uncertainty can be minimized by maintaining coastal groundwater elevations in all sentry wells above mean sea level.
- The interface is shifting within the aquifer zones monitored by sentry wells N02 and N03. The interface, detected onshore in mid-2009, had shifted by January 2010, resulting in improved water quality. Short-term factors affecting the shifting interface include changing recharge conditions and local pumping within a spatially-variable geologic context of interfingered aquifer and aquitard zones. Continued monitoring will help define the relative significance of these factors.
- No known production wells were affected by seawater intrusion.

4.3.3 Measures to Avoid Seawater Intrusion. In response to the early warning of seawater intrusion, the Northern Cities have developed and implemented a water quality monitoring program for the sentry wells and Oceano Observation wells, as described above in Section 4.2.2. The Northern Cities, County FC&WCD, and State of California have also worked cooperatively toward the protection of the sentry wells as long-term monitoring sites. To minimize the threat of seawater intrusion, the Northern Cities have reduced coastal groundwater pumping, decreased overall water use via conservation, and initiated plans, studies and institutional arrangements to secure additional surface water supplies. A summary of the Northern Cities management objectives and activities is presented below in Section 6.

5. Comparison of Demand and Supply

This section provides a comparison of water demand and supply for the four Northern Cities and applied irrigation and rural land uses for current conditions (2009).

In 2009, total urban water demand was 8,031 AFY and the estimated applied irrigation and rural water demands amount to 2,682 AFY and 36 AFY, respectively. The combined total demand estimated for the NCMA in 2009 was 10,749 AFY.

Available urban water supplies are from Lopez, SWP, and groundwater. Lopez Reservoir supplies all four Northern Cities, 2009 deliveries were 4,289 AFY. Pismo Beach and Oceano CSD also receive SWP allotments; in 2009 these two municipalities received 1,990 AFY. The NCMA groundwater supply available to the Northern Cities is estimated to be 4,321 AFY. This total includes the historical groundwater allotment for urban uses of 4,000 AFY based on historical safe yield, and the adjustment for agricultural conversion of 321 AFY. There is currently approximately 100 AFY of additional groundwater supply for urban use available from areas outside of the NCMA. The total available urban water supply is estimated to be 10,690 AFY.

All applied irrigation and rural water demands are supplied by groundwater. As discussed in Section 4.1.3, the historical groundwater safe yield was estimated to be 9,500 AFY, which included 5,300 AFY allocated to applied irrigation and rural uses. The agricultural conversion of 321 AFY to urban supply has since reduced this allocation to 4,999 AFY.

The 2009 demands upon groundwater in the NCMA total to 5,142 AF (2,424 AF of urban demand, 2,682 AF of applied irrigation demand, and 36 AF of rural demand). While this total is well within the historical safe yield of 9,500 AFY, recent changes in the NCMA have shown the basin is dynamic and a static safe yield does not adequately protect the basin. The 2009 occurrence of seawater intrusion in an NCMA sentry well indicates that comparison of groundwater demand with a long-term safe yield value in itself is not sufficient to preserve the integrity of NCMA groundwater supply. Recognizing the potential for seawater intrusion, NCMA management of the groundwater basin includes actions including monitoring, management of groundwater levels and pumping, and water conservation, as discussed in the next section.

6. Management Activities

The management goal for the Northern Cities is to preserve the long-term integrity of water supplies in the NCMA portion of the Santa Maria Groundwater Basin. The Northern Cities and other Northern Parties (namely the overlying owners, San Luis Obispo County and San Luis Obispo FC&WCD) have actively managed surface water and groundwater resources for more than 30 years. This management was first memorialized in the 1983 *Gentlemen's Agreement* and updated in the 2002 Management Agreement. The responsibility and authority of the Northern Parties for NCMA groundwater management was formally established in the 2002 Settlement Agreement, 2005 Stipulation, and 2008 Judgment.

The first section presents the primary NCMA groundwater management objectives and summarizes major historical management activities relevant to the objectives. The second section describes management activities in 2009.

6.1 Management Objectives

The basic objectives of the ongoing NCMA groundwater management are described below in the context of historical management activities.

6.1.1 Share Groundwater Resources and Manage Pumping. A fundamental objective of NCMA management has been to cooperatively share and manage groundwater resources in the NCMA. To this end, in 1983 the Northern Parties mutually agreed on an initial safe yield estimate (defined by DWR) and an allotment of pumping between the urban users and applied irrigation users of 57 percent and 43 percent respectively. The Northern Cities also agreed on pumping allotments among themselves, with later provisions in the 2002 Management Agreement to account for changes such as land conversion. The agreements provide that any increase or decrease in the safe yield will be shared on a pro rata basis. In 2007, the Northern Cities conducted a water balance study to update the safe yield estimate; this resulted in an agreement to maintain the existing pumping allotment among the urban users and established a consistent methodology to address agricultural land use conversion. The water balance study also highlighted the threat of seawater intrusion as the most important potential adverse impact to consider in managing the basin. Another potential adverse impact of localized pumping includes reduction of flow in local streams, notably Arroyo Grande. The Northern Cities (as Zone 3 contractors) have participated with the County and FC&WCD in preparation of the Arroyo Grande Creek Habitat Conservation Plan (HCP) that addresses reservoir releases to maintain both groundwater levels and fish flows in the creek. The potential impacts of pumping on inelastic subsidence of the ground surface are not significant. The relatively small size of the NCMA and its proximity and hydraulic connection to the ocean means that excessive pumping will not result in groundwater declines that are sufficient to cause subsidence. Instead, groundwater level declines will induce seawater intrusion that maintains groundwater levels, but degrades its quality.

6.1.2 Monitor Supply and Demand and Share Information. Another fundamental objective of NCMA management has been regular monitoring of water supply and demand and sharing of information, including data on hydrologic conditions, water supply and demand, and groundwater pumping, levels, and quality. This was first established in 1983 and then formalized in 2002 to include quarterly meetings. The current monitoring program is conducted in accordance with the 2005 Stipulation and 2008 Judgment, guided by the July 2008 Monitoring Program for the NCMA, and summarized in the Annual Reports.

6.1.3 Manage Groundwater Levels and Prevent Seawater Intrusion. An objective of NCMA management is to prevent seawater intrusion through the management of groundwater levels. This objective is closely related to the objectives to manage pumping, monitor supply and demand, and share information, but specifically recognizes the proximity of production wells to the coast and the threat of seawater intrusion. The Northern Cities, County and San Luis Obispo FC&WCD have long cooperated in the monitoring of groundwater levels, including measurement of groundwater levels in the sentry wells at the coast.

6.1.4 Protect Groundwater Quality. A general objective of NCMA management is to protect groundwater quality. This objective is closely linked with the objective for monitoring and data sharing. It recognizes not only the threat of seawater intrusion along the coast, but other water quality problems that could affect the integrity of groundwater supplies, resulting in loss of use or expensive water treatment processes. Current activities related to this objective include the monitoring program and updates in the Annual Reports. Key issues are local nitrate and selenium concentrations in excess of primary drinking water standards; these have been addressed through actions including provision of municipal water to impacted private wells and through blending to ensure that delivered water meets all drinking water standards.

6.1.5 Encourage Water Conservation. An objective of NCMA management is to encourage water conservation. This objective is linked to the monitoring of supply and demand and the management of pumping; specifically, the Northern Cities have agreed that a decrease in the groundwater safe yield would be shared. This would be accomplished by using other sources (e.g., recycled water or SWP water) or through water conservation. Water conservation activities are summarized in various documents produced by the Northern Cities, including the Urban Water Management Plans of Arroyo Grande, Grover Beach, and Pismo Beach and in the NCMA Annual Reports.

6.1.6 Manage Cooperatively. Since 1983, NCMA management has been based on the premise that groundwater management is best accomplished through cooperative efforts of the affected parties themselves. The four Northern Cities represent the core, with ongoing collaboration with the County, FC&WCD, and other local and state agencies and participation of other organizations as appropriate to the issues of the time. In addition to the monitoring, management, data sharing, and annual reporting consistent with the Judgment, the Northern Cities also communicate water issues in their respective public meetings, and participate in the Water Resources Advisory Council (the County-wide advisory panel on water issues). The cities of Arroyo Grande, Grover Beach, and Pismo Beach adopted the 2007 San Luis Obispo County Integrated Regional Water Management Plan. The IRWMP promotes integrated regional water management to ensure sustainable water uses, reliable water supplies, better water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy. The Plan integrates all of the programs, plans, and projects lead by entities within the region into water supply, water quality, ecosystem preservation and restoration, groundwater monitoring and management, and flood management programs.

6.2 Update on Management Activities

The Northern Cities, both individually and jointly, are engaged in water resource management projects, programs, and planning efforts that address water supply and demand issues, particularly provision of long-term sustainable supply. This section provides an update for major management activities during 2009.

6.2.1 Control of Groundwater Levels and Seawater Intrusion. In 2009, in light of prolonged drought and continuing groundwater development in the Santa Maria Groundwater Basin, the sentry well monitoring program was intensified to include quarterly water quality sampling and analysis. A project to renovate the sentry wells also was initiated. Currently, the Northern Cities are developing specific groundwater level and quality objectives for the sentry wells. For example, an objective could specify that groundwater elevations in a sentry well will be maintained above 5 feet mean sea level in average conditions, and that a decrease of groundwater levels below a defined elevation (e.g., zero feet mean sea level) for a specified duration will mandate a decrease in pumping in specified production wells.

6.2.2 Other Responses to Drought and Seawater Intrusion. The Northern Cities have taken additional actions to mitigate the risks to groundwater associated with the prolonged drought and the identification of seawater intrusion within the NCMA. These actions include requests for emergency supplemental water supplies, increased use of SWP water, restrictions on development, conservation, and reductions in groundwater use.

- On November 24, 2009, each of the Northern Cities municipalities submitted letters to San Luis Obispo County staff informing them of the signs of seawater intrusion in the sentry wells. Each letter requested that the County grant a short-term delivery of 1,500 to 2,500 AF of State Water Project at the Lopez turnout. The County is currently working with the Central Coast Water Authority to discuss this short-term request.

- On August 12, 2008, the City of Arroyo Grande declared a "Severely Restricted Water Supply Condition," acknowledging utilization by Arroyo Grande of 99 percent of its total water supply during the past 12 months. This declaration triggered immediate water conservation actions including specific prohibitions (e.g., washing vehicles without a shut-off nozzle) and expanded water conservation assistance and incentives. A flyer circulated by the city describing these measures is attached as Appendix C. These emergency actions remain in place as of April 2010. In addition, the City issued a Land Use application moratorium in October 2009. This restriction limits new development to previously approved projects and projects with applications in process prior to the moratorium. The moratorium has been extended to April 2010 and may be extended further based on water supply conditions.

- The City of Grover Beach developed a Water Shortage Contingency Plan, outlined in their Urban Water Management Plan, to enact water conservation measures based on the current basin conditions. On June 18, 2007, the City of Grover Beach declared a Stage I Water Alert in response to drought conditions. The Stage I Water Alert is triggered when rainfall is 65 percent or less than normal. Stage I actions involve voluntary reduction of water consumption. In August 2009, the City Council upgraded the Water Alert to Stage II Water Shortage which instituted several voluntary water reduction measures including refraining from using potable water for street cleaning, construction, planting turf, washing cars, etc. If drought conditions continue, the city council could declare a Stage III Water Storage, making these measures mandatory.

- The City of Pismo Beach and Oceano CSD have not declared similar drought-related water supply limitations, but have decreased their groundwater pumping in response to seawater intrusion.

6.2.3 Cooperative Water Supply Planning and Management. Water supply planning activities in 2009 included a water transfer agreement between Arroyo Grande and Oceano CSD, ongoing recharge using storm water detention ponds, sentry well maintenance, data sharing, regional agreements, and ongoing studies to acquire new water supply sources. In addition, Oceano CSD is in the process of completing its Water and Sewer Master Plan that details their water system and provides water shortage contingency plans.

- **Water Transfer.** In January 2009, the City of Arroyo Grande entered into an agreement with OCSD to purchase an additional 100 AF per year (AFY) of supplemental water supply. This temporary agreement will be in place for the next five years; the agreement may be made permanent, if adequate resources exist.
- **Storm Water Ponds.** The Cities of Arroyo Grande and Grover Beach and the Oceano Community Services District maintain storm water retention ponds. These ponds collect storm water runoff, allowing it to recharge the underlying aquifers. There are approximately 140 acres and 48 acres of detention ponds in Arroyo Grande and Grover Beach, respectively. The existing storm water detention pond in Oceano is approximately half an acre. Grover Beach recently modified its storm water system to direct additional flow into one of its recharge basins. San Luis Obispo County is currently evaluating creation of a 50-acre storm water detention pond near the Oceano Airport. This pond would also create an opportunity for recharge to the groundwater basin. The *Oceano Drainage and Flood Control Study* documents the need for such a pond and identifies the steps require to implement the facility.
- **Sentry Wellhead Maintenance.** The Northern Cities have been working with San Luis Obispo County and the State of California to rehabilitate the sentry well monitoring network. The sentry wells are located on state land, managed and monitored by the County, and sampled by the Northern Cities. These three entities have developed a rehabilitation plan that would secure the wellheads from tampering or inadvertent entry of water or materials into the wells. This in turn will improve the reliability of water quality data from these wells. The Northern Cities are currently awaiting a finalized right-of-entry agreement between the County and the State.
- **Data Sharing.** The Northern Cities have been cooperating with San Luis Obispo County and the Nipomo Mesa Management Area (NMMA) in the improvement of regional groundwater monitoring. In 2009, the Northern Cities surveyed the wellhead elevations of key monitored wells; these data were shared with both the County and NMMA. For Annual Report preparation, the Northern Cities and NMMA also shared water quality data and collaborated on the interpretation of groundwater level data and preparation of water elevation contour maps.

6.2.4 Water Conservation. The Northern Cities are committed to long-term water supply reliability. To reach this goal, the cities have pursued water conservation activities to reduce water demand and thus require less water supply. The Cities participate in a wide range of water conservation activities designed to reduce water use and educate the public.

The City of Arroyo Grande created a part time water conservation coordinator staff position in March 2009. The coordinator manages existing conservation activities, encourages public participation, and creates new conservation programs for the community. The City of Arroyo Grande continues to implement water conservation programs including a “Cash for Grass” rebate program, washing machine rebates, a smart irrigation controller rebate program, plumbing retrofit rebates, water audits, public information and education, and other programs. In addition to these programs, the City of Arroyo Grande offered free monthly educational seminars (from April to November) that focused on sustainable landscape principles and water conservation. Videos of the classes are available online and are also shown on the local public access channel. The City’s water conservation efforts have been very successful to date; the “Cash for Grass” program has prompted the removal of over 60,000 square feet of grass, 43 washing machine rebates have been processed, and 10 water audits of commercial and large Homeowners Associations have been completed. These measures have decreased water use per residential connection by 10 percent (from 190 gallons per household per day to 170 gallons per household per day). Public outreach is performed through a variety of channels including the city’s website, bill inserts, local contractors, email, and word of mouth. The incentive flyer describing the city’s programs is attached as Appendix C.

The City of Grover Beach’s ongoing water conservation activities include a “Cash for Grass” rebate, a water-efficient washing machine rebate program, and smart irrigation controller and sensor rebate programs. Ongoing water conservation activities in Pismo Beach include water hardware retrofitting, water audits, and public outreach. Water audits are provided free of charge to customers and include a review of water bills, a check of indoor and outdoor plumbing and suggest repairs or changes.

6.2.5 Alternative Water Supply Studies. In order to provide a reliable and sustainable water supply for the NCMA, the Northern Cities are studying alternative sources of water supply. An expanded portfolio of water supply sources will help to reduce the effect of water shortages and assist in the sustainable management of the groundwater aquifer. These alternative sources include:

- **State Water Project.** As discussed above, the Northern Cities have requested a short-term allocation of 1,500 to 2,500 AF for the NCMA. OCSD and Pismo Beach are currently SWP customers and could use additional water immediately. Grover Beach is not a SWP customer; however, Grover Beach could use the water assuming that the allocation is granted. Direct use of SWP water by the City of Arroyo Grande would require a ballot measure; the City is considering adding such a measure to the November 2010 ballot to lift its restrictions on SWP water use.

- **Water Recycling.** The City of Arroyo Grande has initiated a feasibility study of water recycling in the NCMA. Treated water from two wastewater treatment plants could be used as non-potable irrigation for parks, cemeteries, open spaces, and other areas. Completion of the feasibility study is expected in April 2010.

- **South San Luis Obispo County Desalination Funding Study.** The City of Arroyo Grande, City of Grover Beach, and Oceano CSD secured a Proposition 50 grant for an evaluation of seawater desalination as a supplemental drought-proof water supply. The Desalination Funding Study was completed in October 2008. Desalination remains an option for the NCMA; however development of this source has been delayed due to funding concerns.

- **Lopez Reservoir Expansion.** In 2008, San Luis Obispo County sponsored a preliminary assessment of the concept of installing gates at the Lopez Dam spillway. Next steps would include assessment of dam safety, evaluation of project benefits (including identification of participating parties), identification of alternatives, engineering feasibility studies, environmental review, permitting, design, and construction. Additional exploration of this option is pending consideration of other alternative water supply sources.

Figures

Figure 1
Santa Maria Groundwater Basin

April 2010

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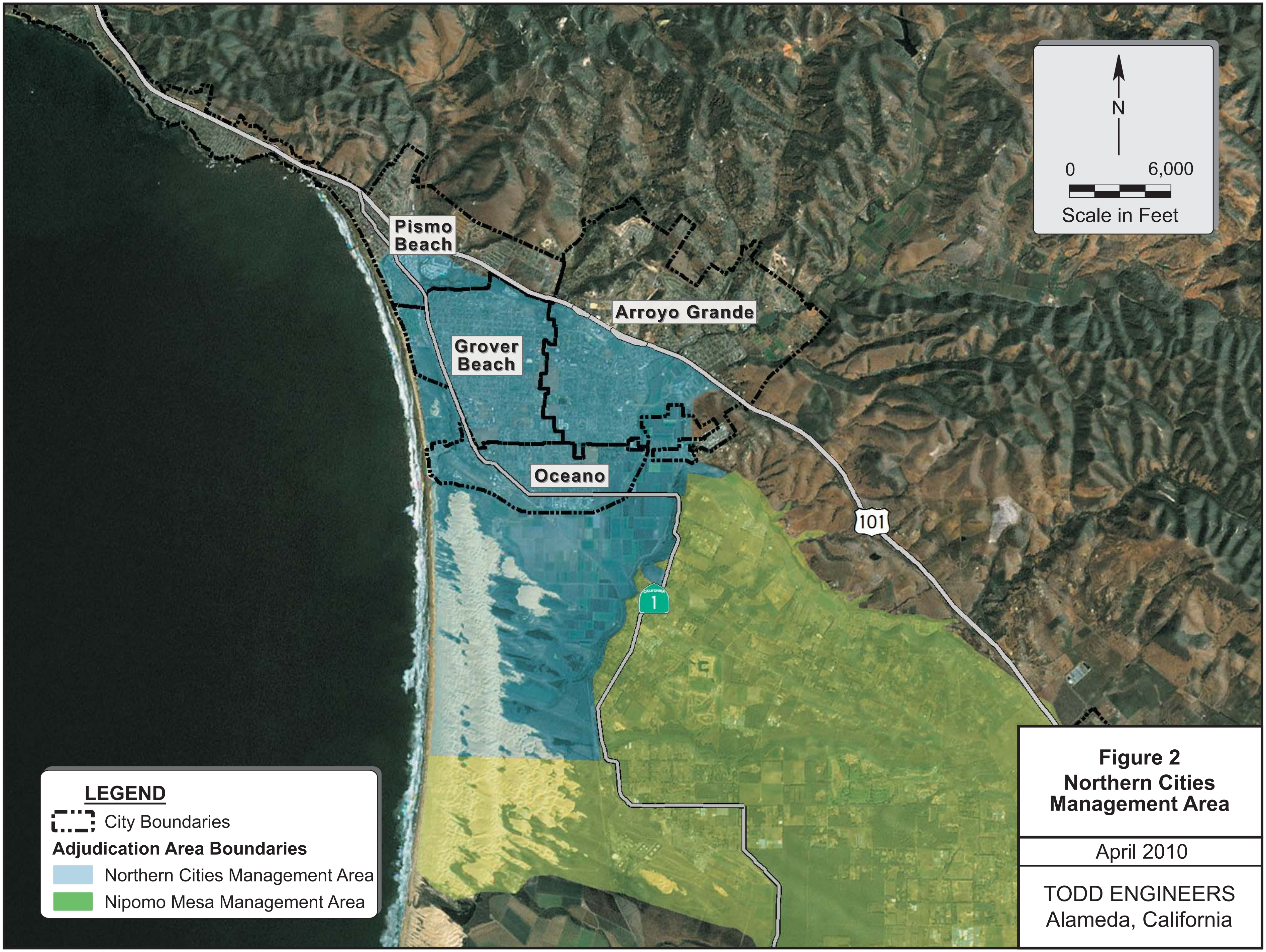

Figure 2
Northern Cities Management Area

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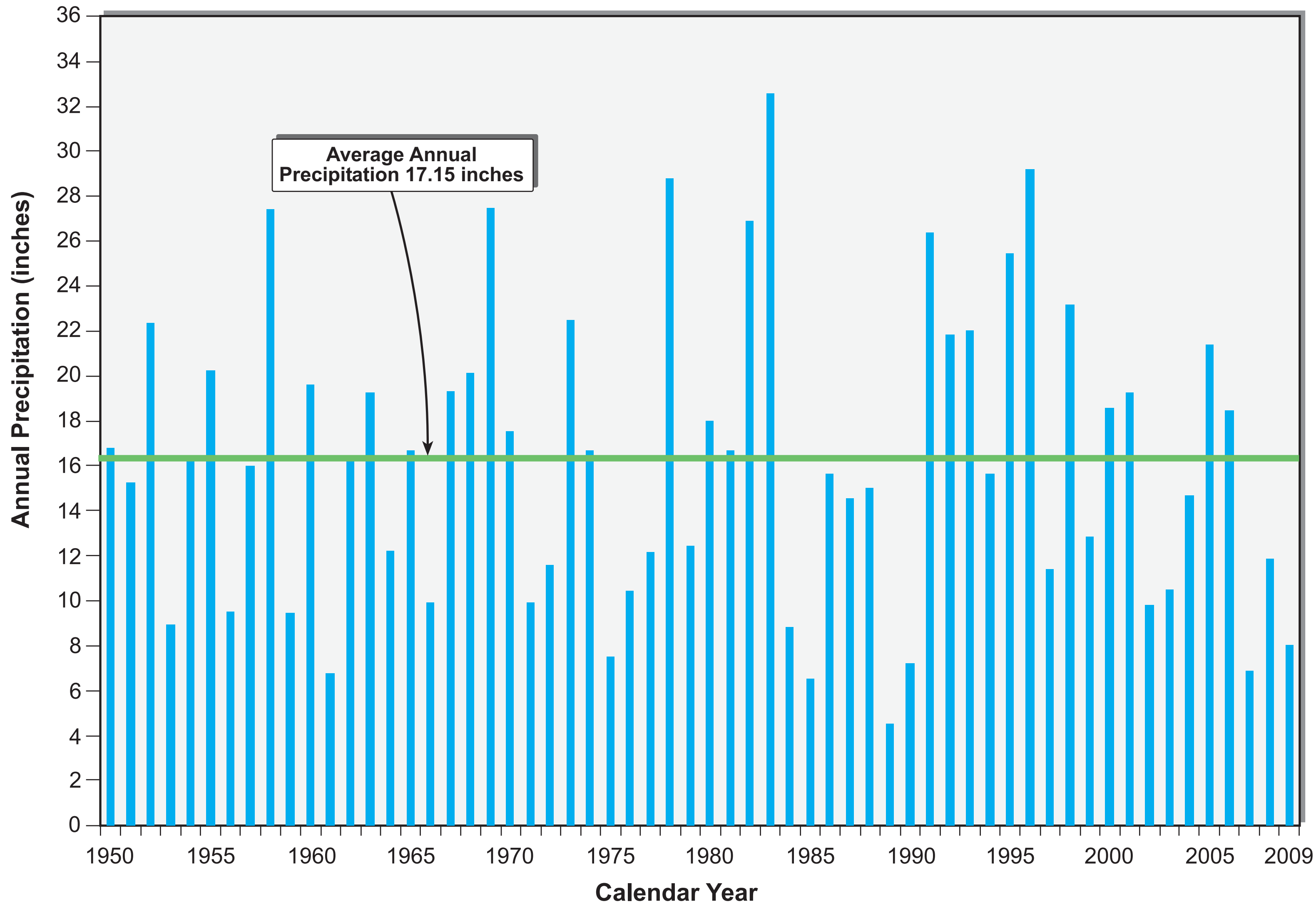
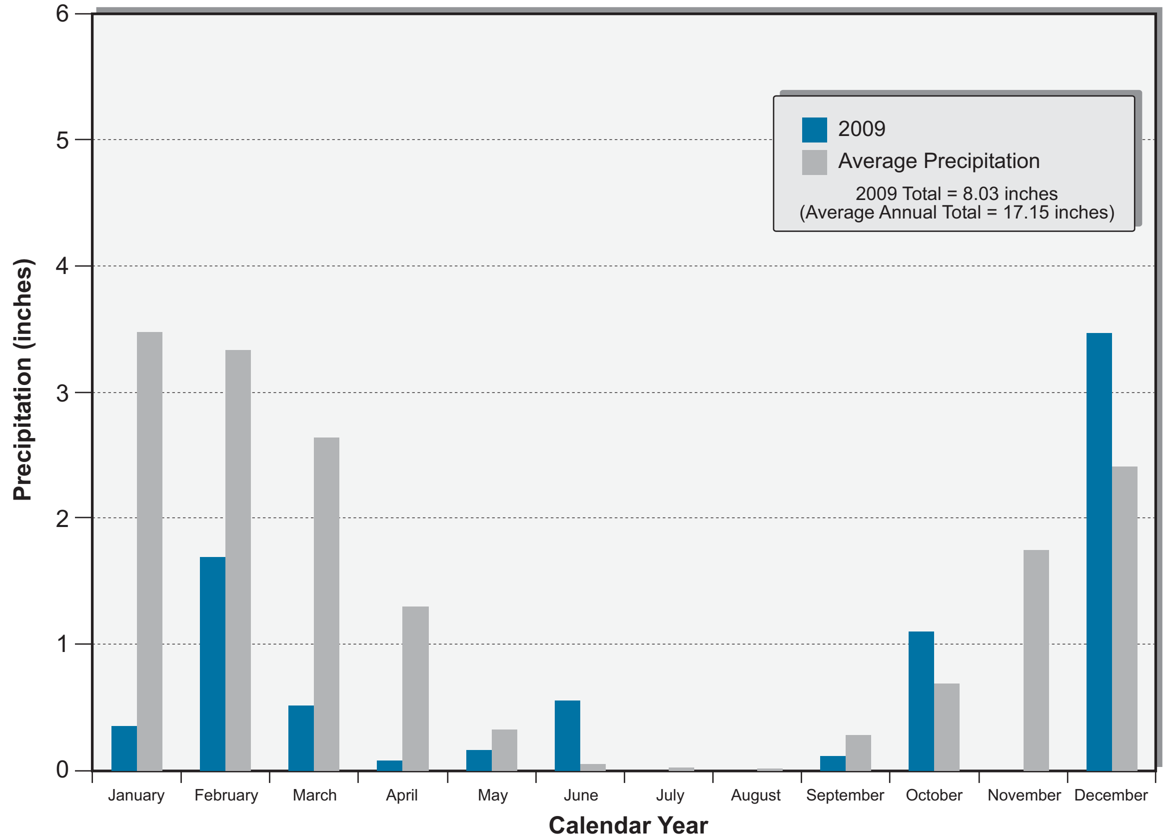
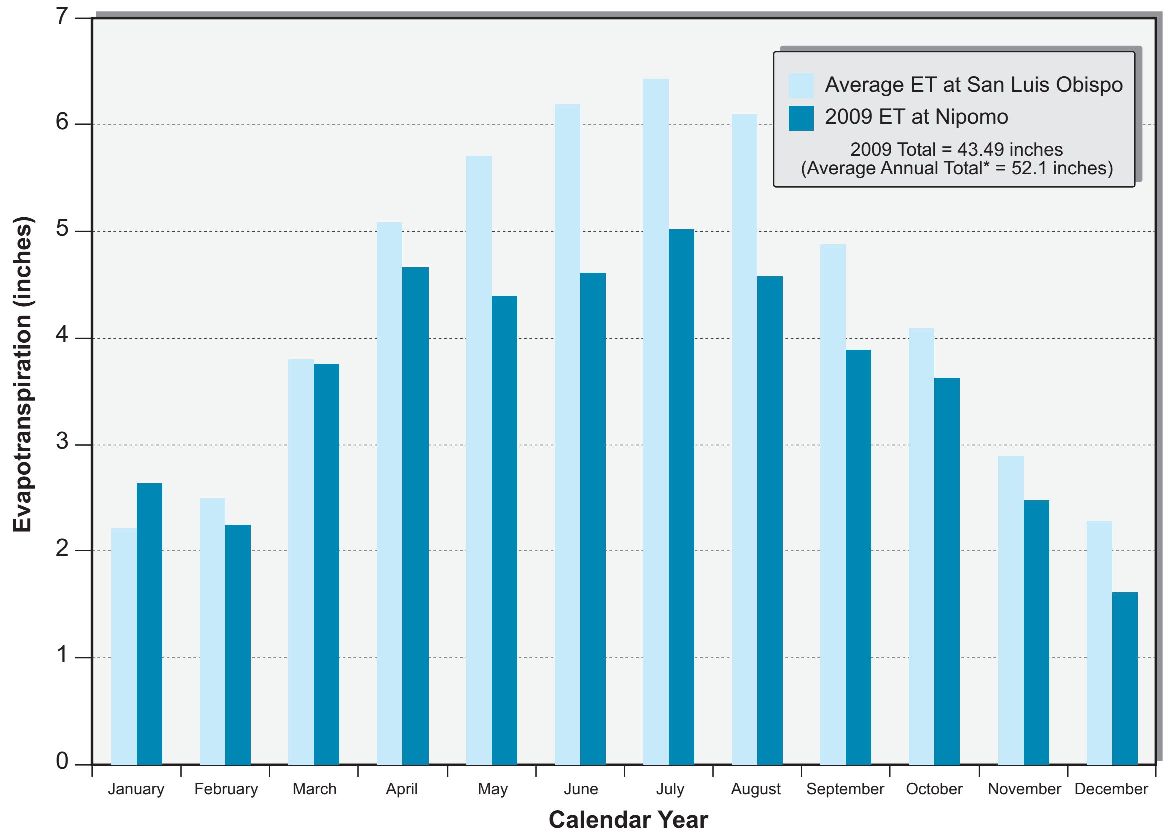


April 2010	**Figure 3**
TODD ENGINEERS Alameda, California	**Annual Precipitation** **1950 - 2009**





April 2010

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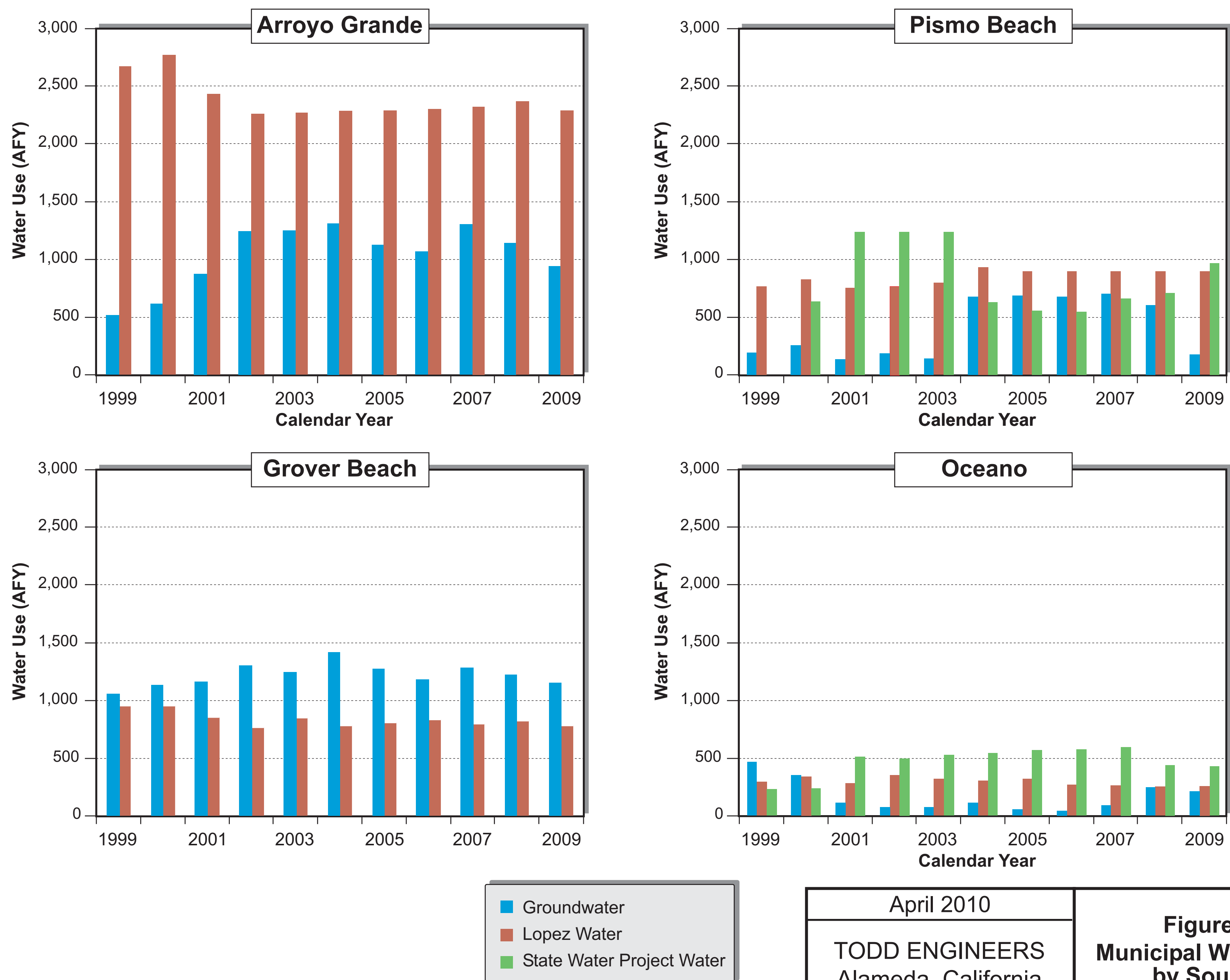
Figure 4
Monthly 2009 and Average Precipitation and Evapotranspiration



April 2010

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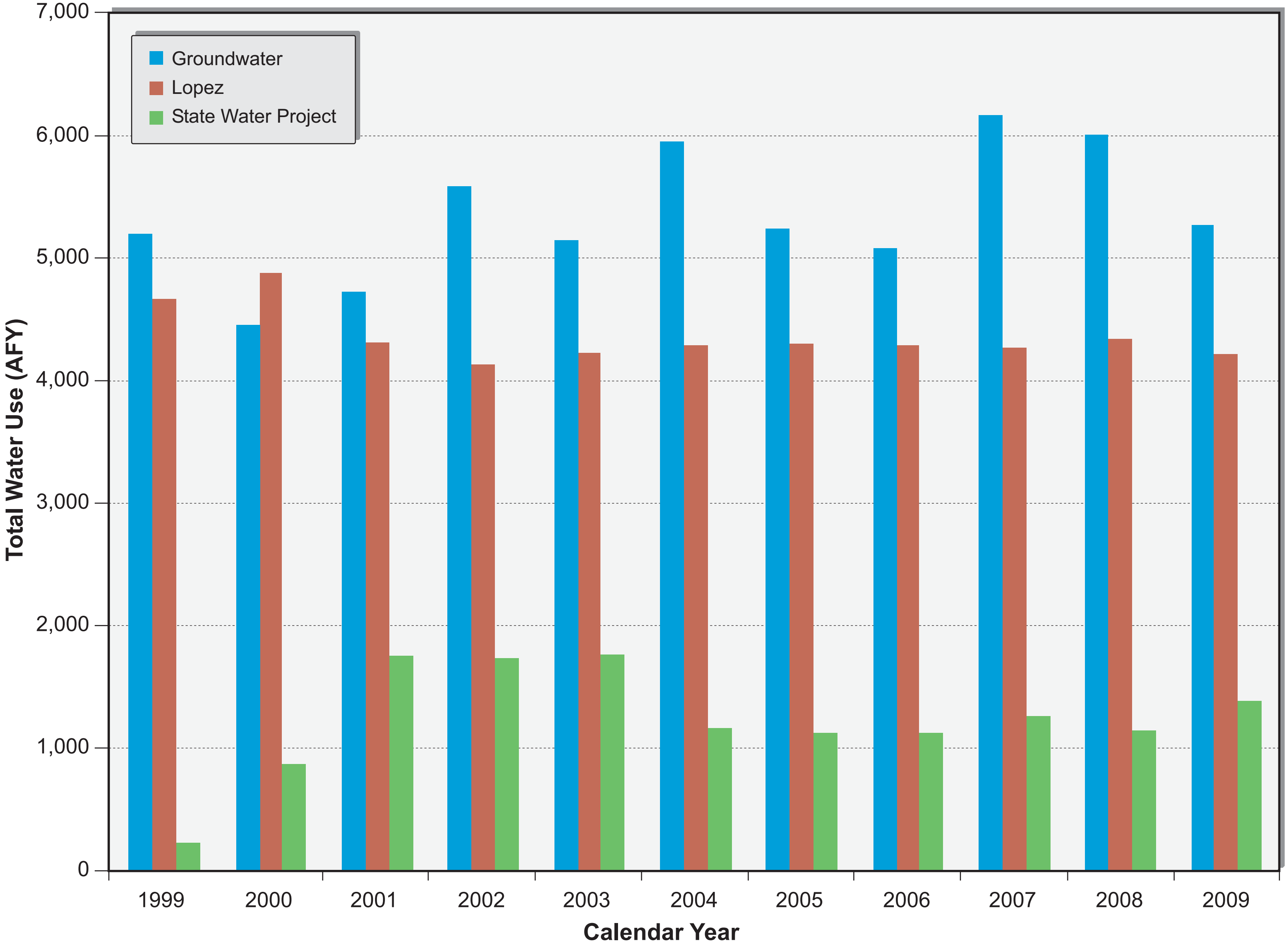
Figure 5
Municipal Water Use by Source



April 2010

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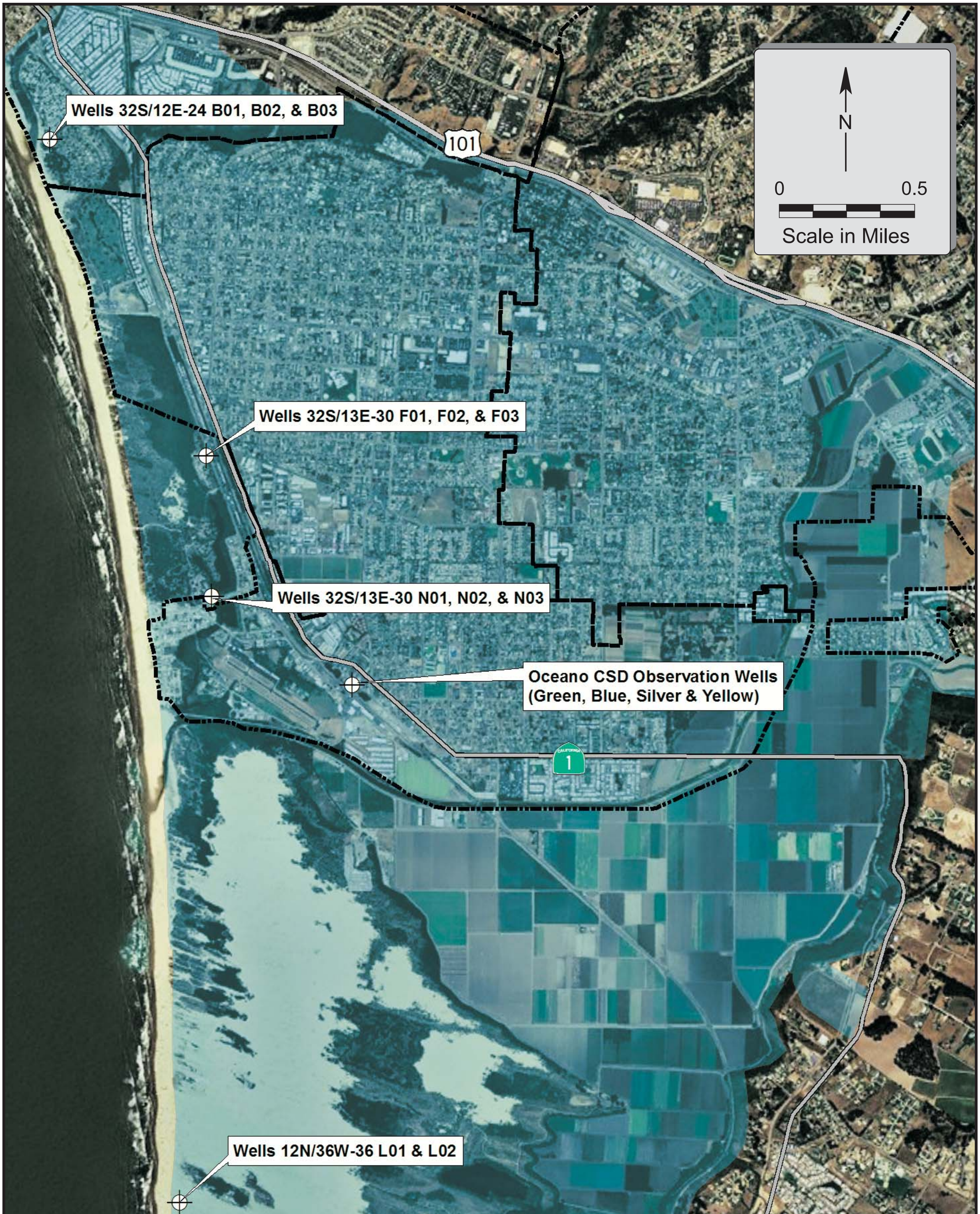
Figure 6
Total Water Use by Source



April 2010

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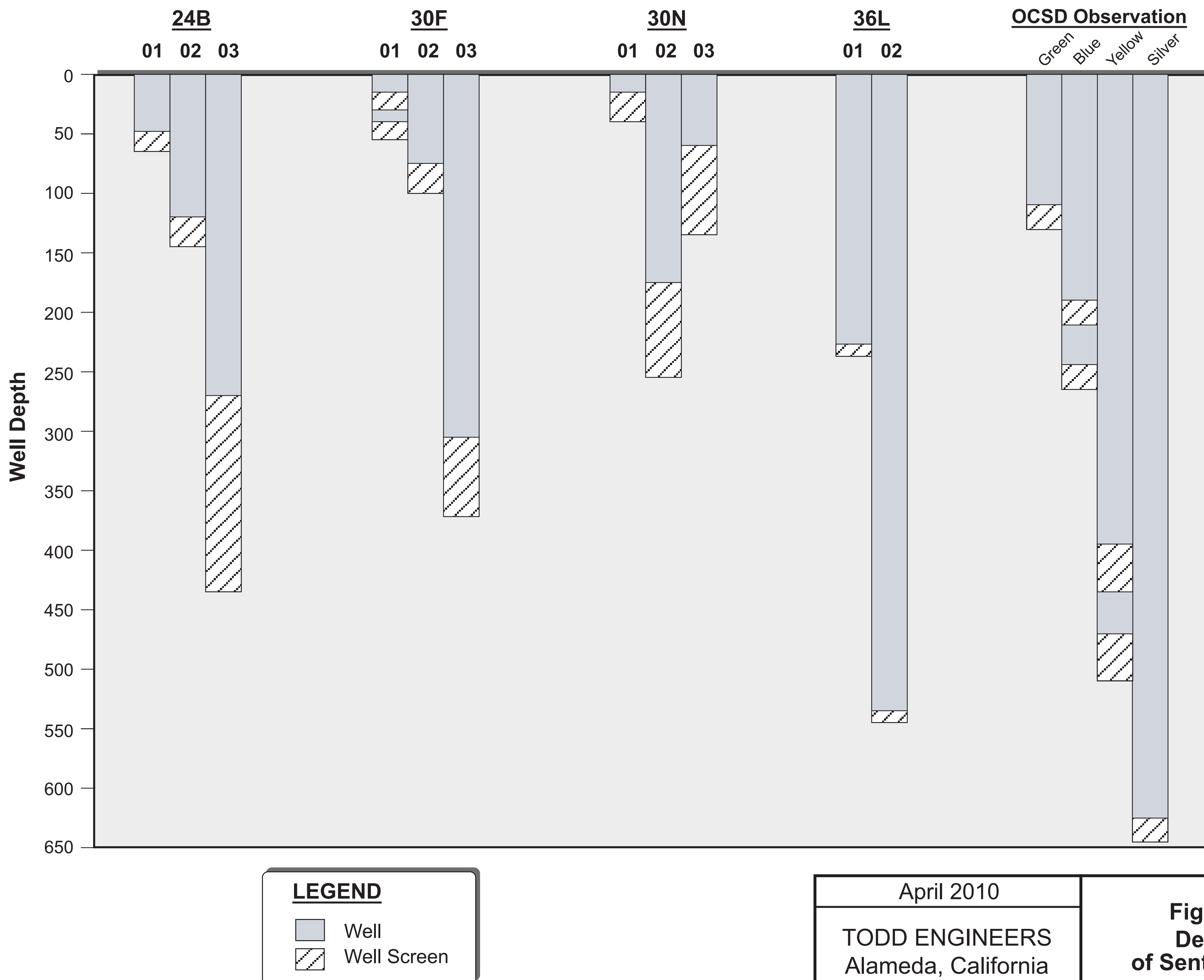
Figure 7
Location of Sentry Wells



April 2010

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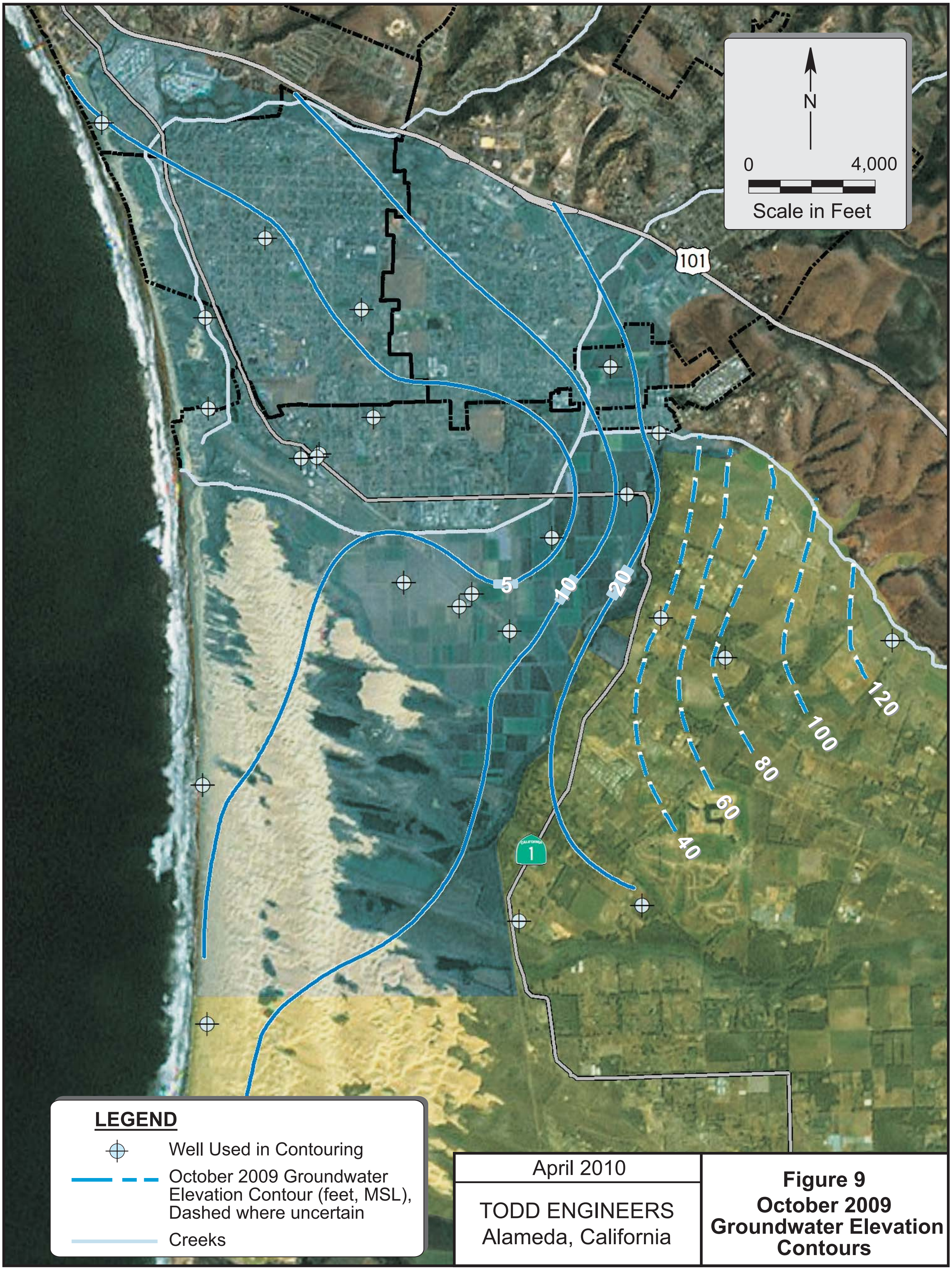
Figure 8
Depths of Sentry Wells



LEGEND

Well Used in Contouring

October 2009 Groundwater Elevation Contour (feet, MSL), Dashed where uncertain

Creeks

April 2010	**Figure 9**
TODD ENGINEERS Alameda, California	**October 2009 Groundwater Elevation Contours**

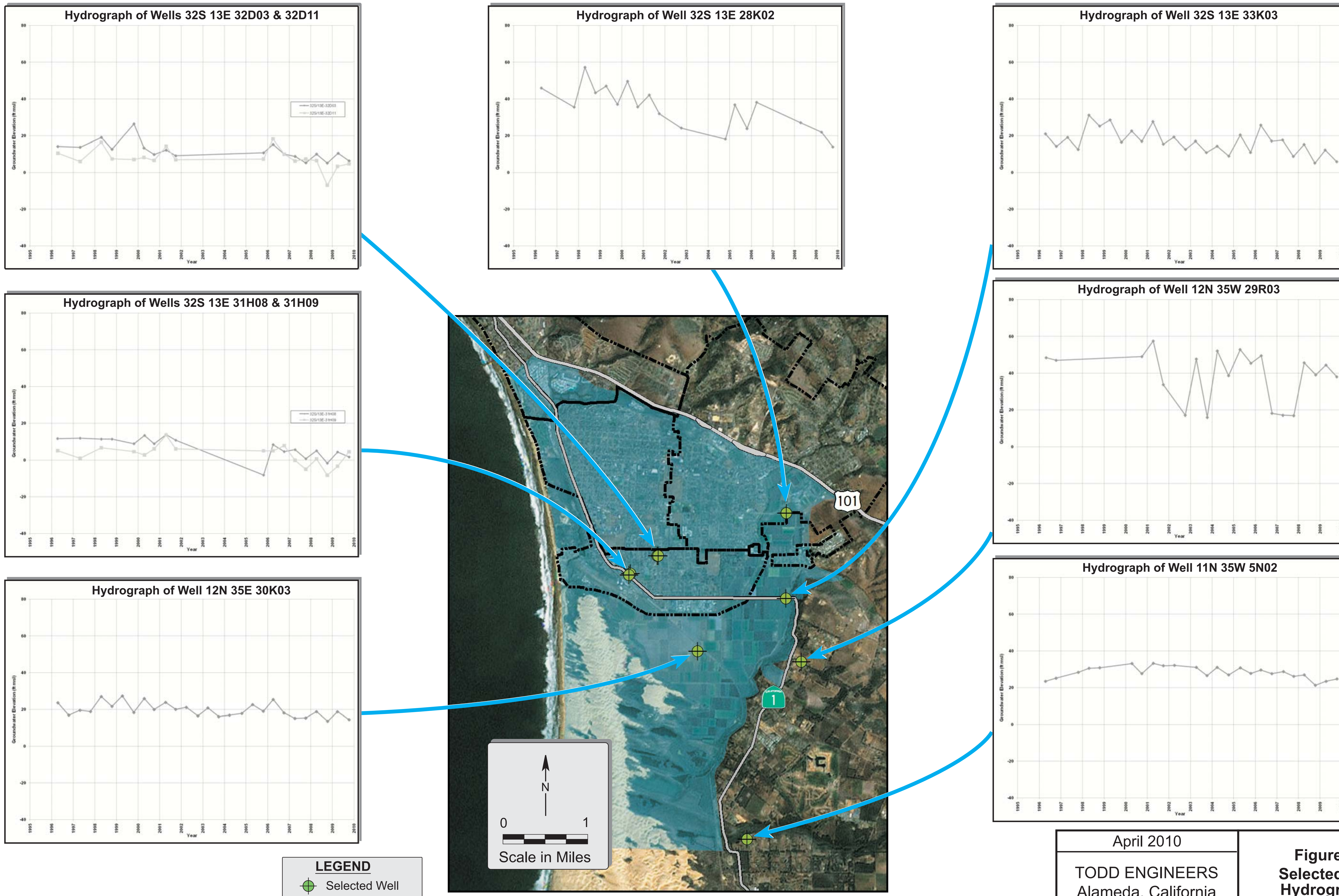


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Figure 10
Selected Well Hydrographs

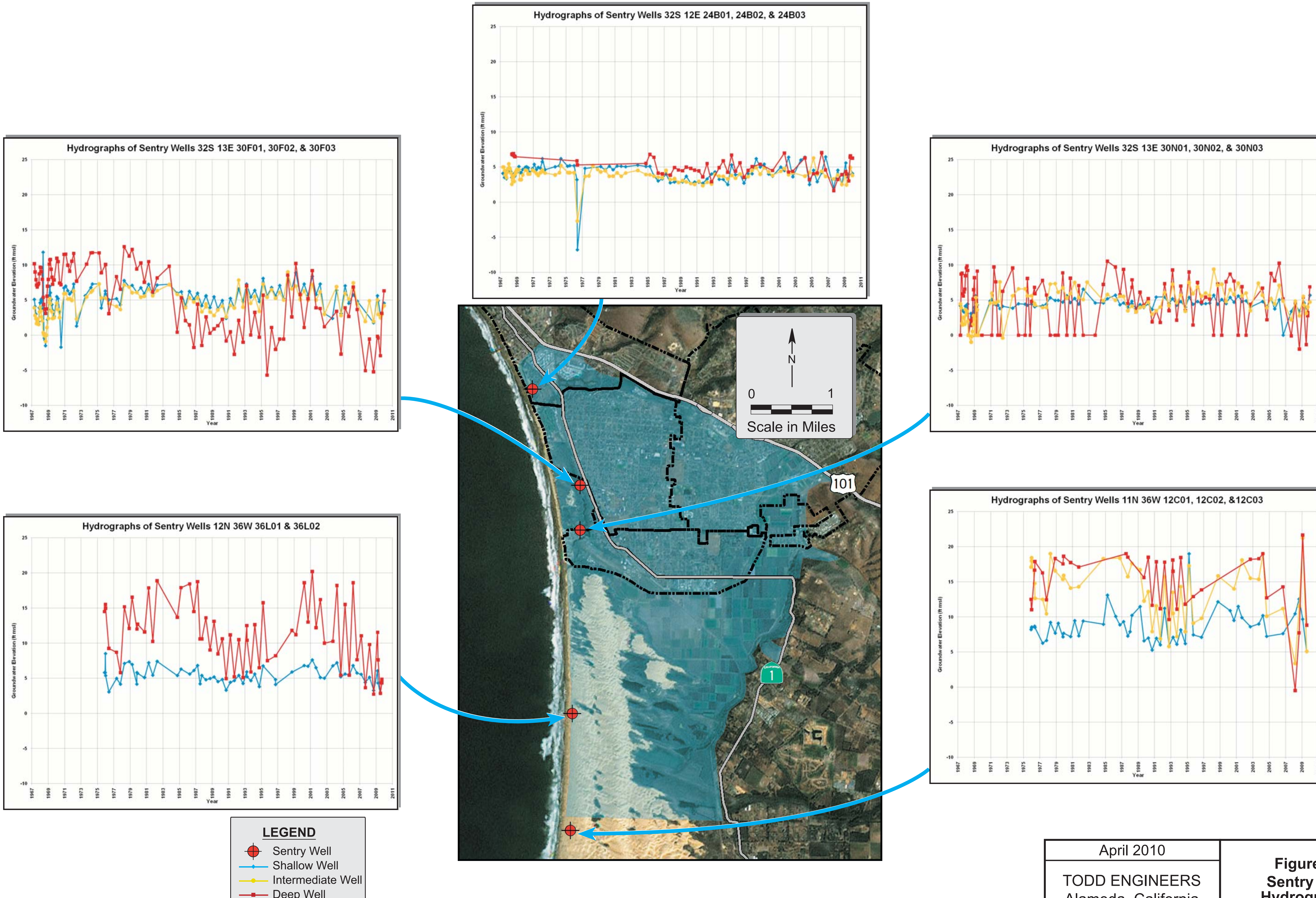

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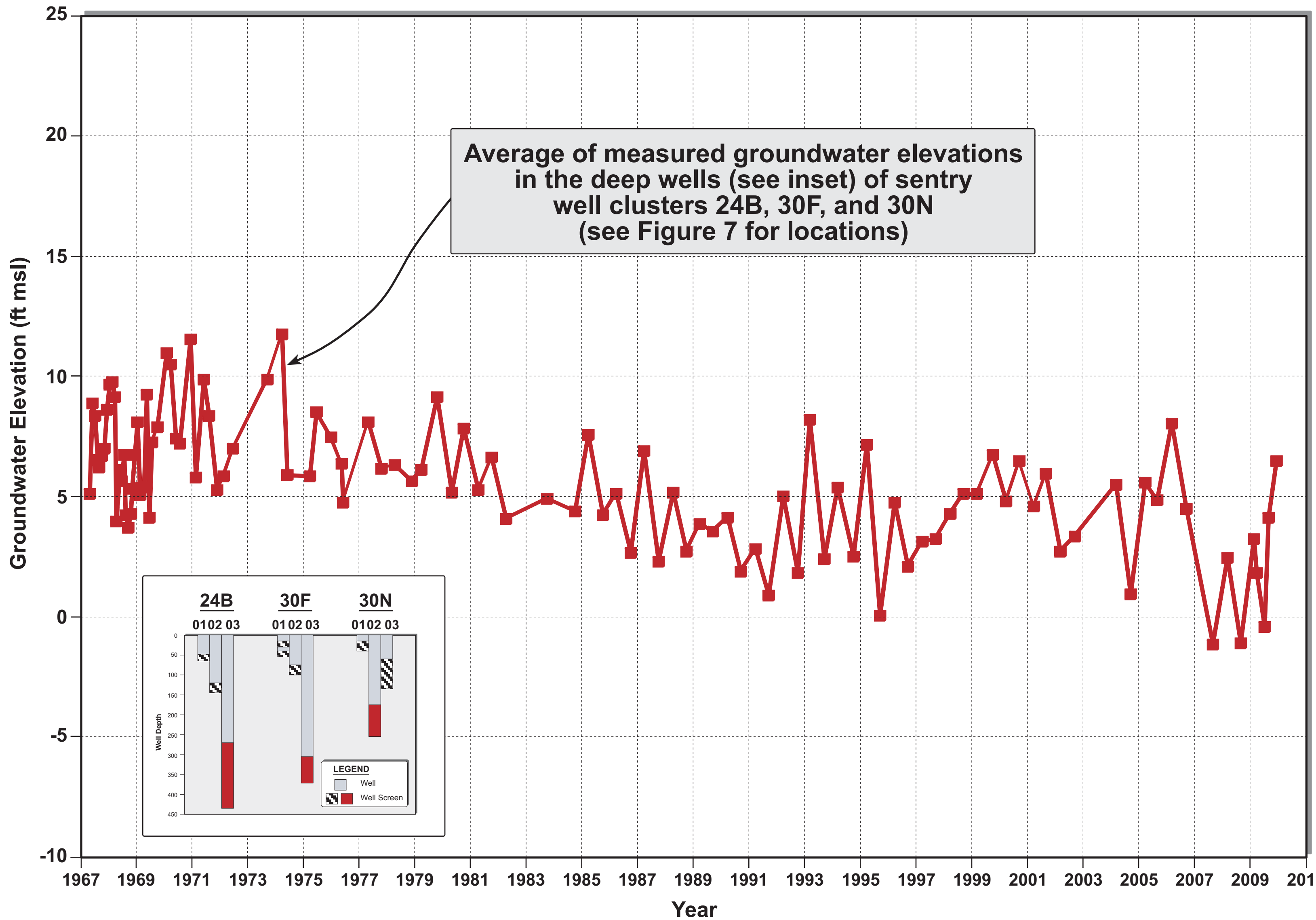
Figure 11
Sentry Well Hydrographs



April 2010

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Figure 12
Hydrograph of Average Deep Sentry Well Elevations

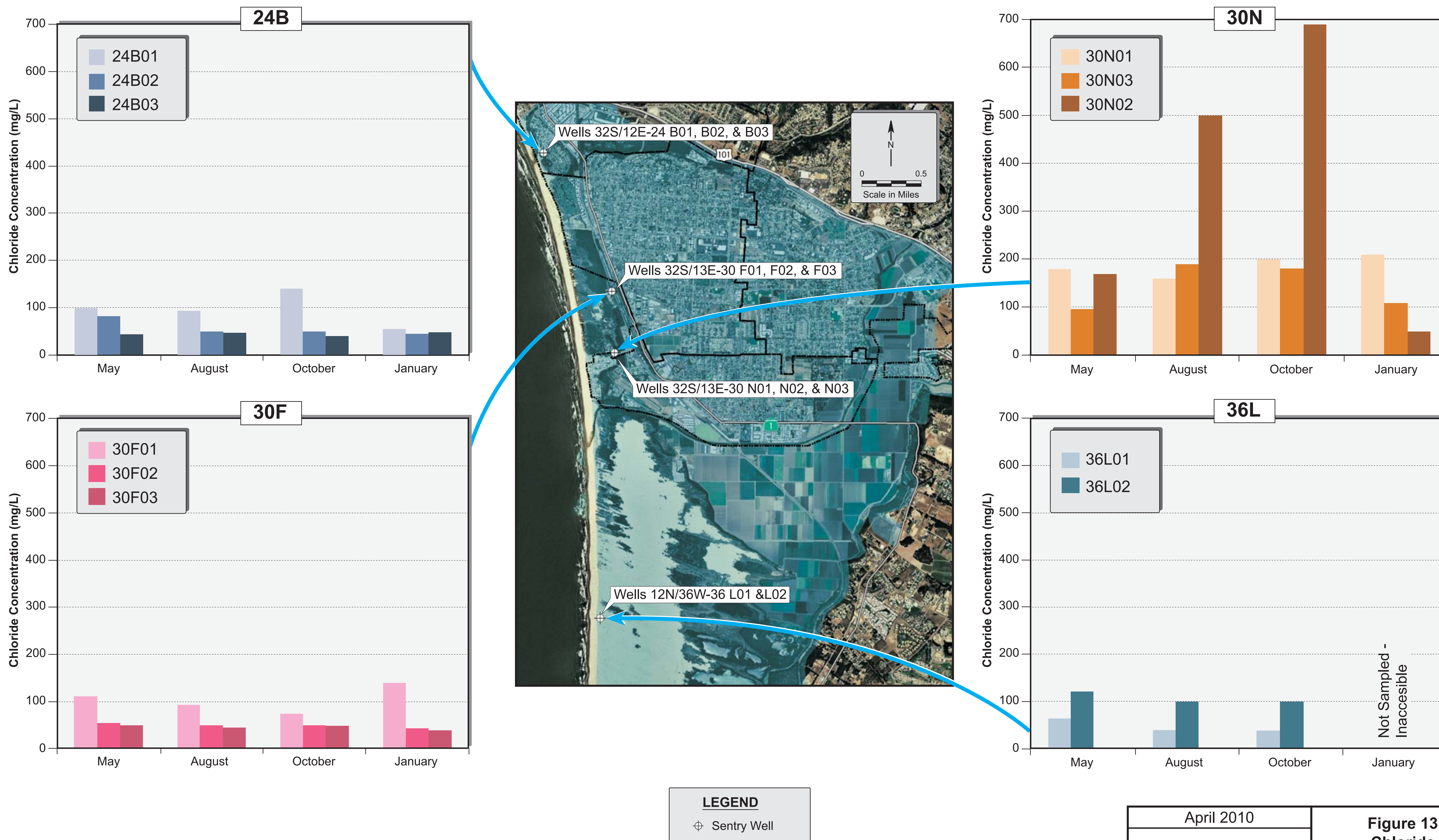

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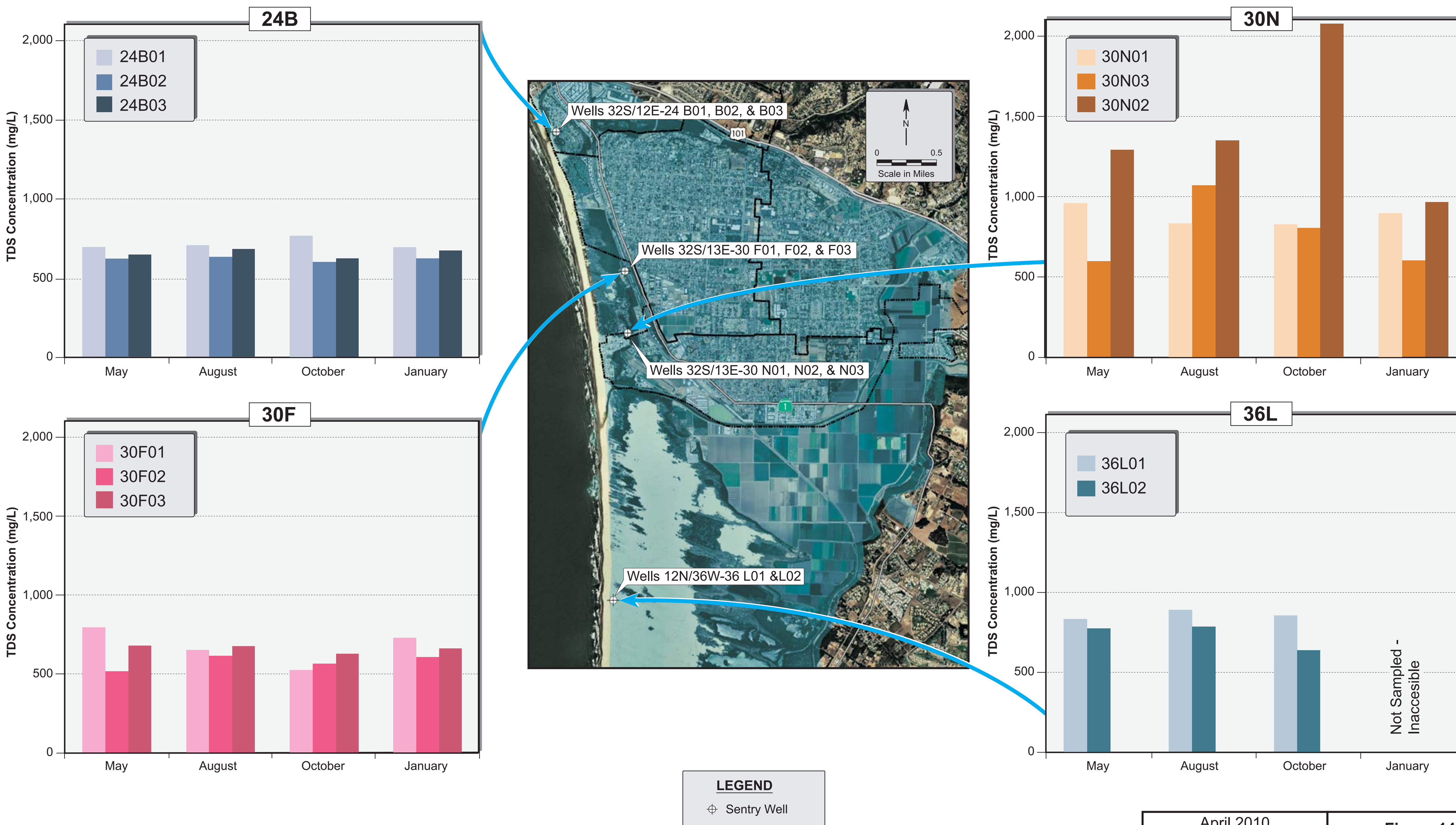
Figure 13
Chloride Concentrations Over Time in Sentry Wells



April 2010

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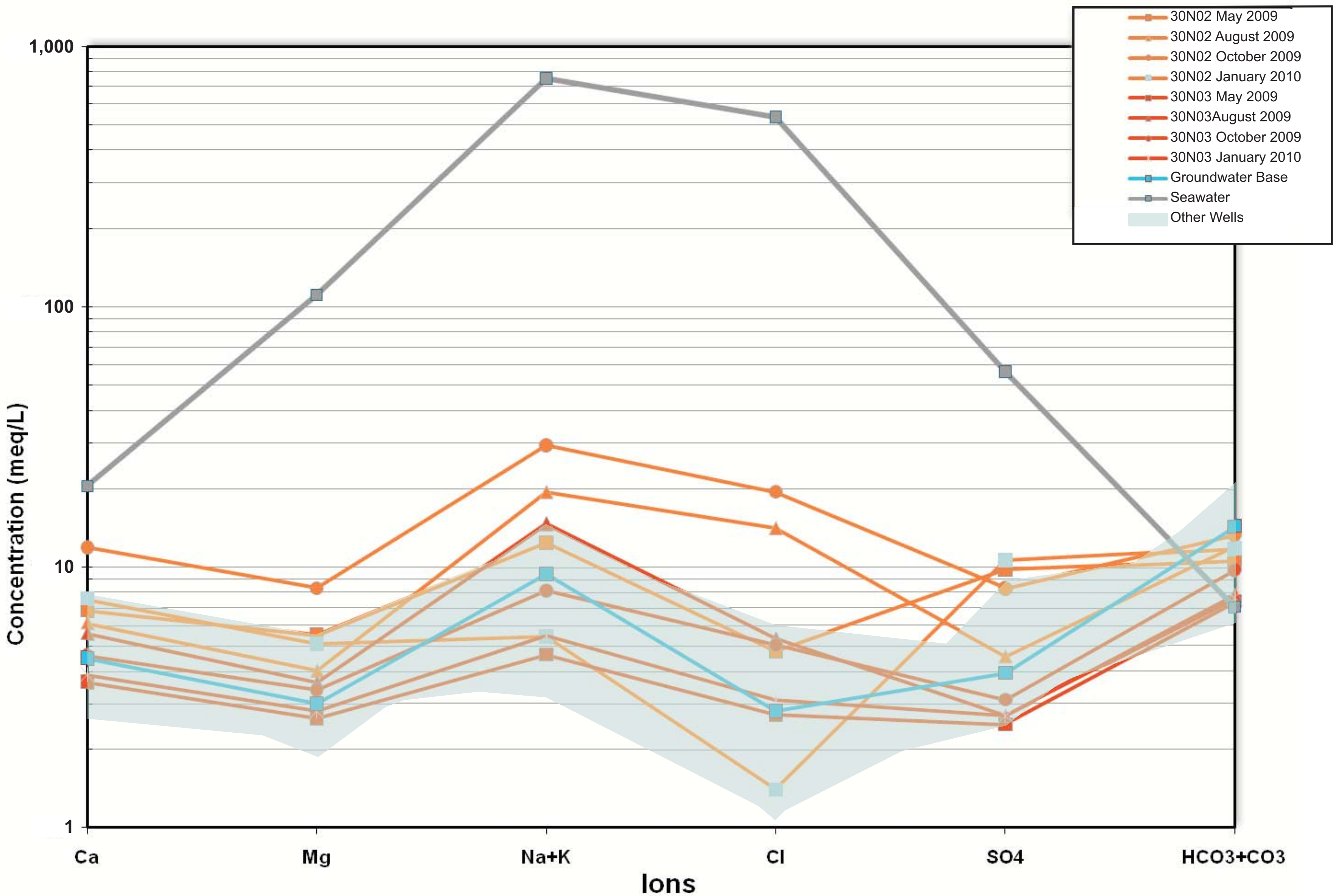
Figure 14
Total Dissolved Solids Concentrations Over Time in Sentry Wells



April 2010

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Figure 15
Schoeller Diagram for Sentry Wells, 2009 and January 2010

Appendix A
Climactic Data

Table A-1. Monthly Precipitation Data from Pismo Beach (1993 -2005) and Oceano (2005-2009)
All values in inches

Calendar Year	JAN	FEB	MAR	APR	May	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1993	7.95	6.65	4.02	0.18	0.00	0.22	0.00	0.00	0.00	0.53	2.09	0.37	22.01
1994	2.48	4.41	1.64	0.78	0.00	0.00	0.00	0.02	1.19	1.13	2.67	1.32	15.64
1995	10.80	1.41	7.44	0.94	1.83	0.75	0.00	0.00	0.04	0.08	0.40	1.79	25.48
1996	3.52	8.41	1.68	0.98	0.43	0.00	0.00	0.00	0.03	2.08	4.41	7.67	29.21
1997	7.18	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.16	0.00	3.99	11.43
1998	2.97	12.42	3.78	0.00	3.62	0.06	0.00	0.00	0.29	0.00	0.00	0.00	23.14
1999	2.59	1.48	4.61	2.39	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.06	12.82
2000	2.89	9.29	1.53	2.75	0.14	0.30	0.00	0.00	0.18	1.48	0.00	0.02	18.58
2001	3.65	5.94	2.98	1.04	0.02	0.04	0.00	0.01	0.01	0.61	3.36	1.59	19.25
2002	1.28	0.42	1.22	0.76	0.10	0.00	0.01	0.02	0.03	0.01	2.12	3.80	9.77
2003	0.29	2.19	1.52	1.27	0.84	0.01	0.00	0.00	0.00	0.22	1.24	2.89	10.47
2004	1.32	4.01	0.70	0.00	0.02	0.00	0.00	0.00	0.00	3.09	2.59	2.93	14.66
2005	4.95	3.79	2.28	1.64	0.00	0.39	0.00	0.00	2.01	0.87	2.76	2.72	21.41
2006	5.35	1.22	4.53	3.78	1.38	0.00	0.00	0.00	0.00	0.00	0.00	2.20	18.46
2007	1.22	1.69	0.28	0.55	0.04	0.00	0.00	0.04	0.00	0.55	0.08	2.44	6.89
2008	5.94	1.93	0.00	0.39	0.00	0.00	0.00	0.00	0.04	0.16	1.38	2.01	11.85
2009	0.35	1.69	0.51	0.08	0.16	0.55	0.00	0.00	0.12	1.10	0.00	3.46	8.03

Table A-2. Monthly Evapotranspiration Data from San Luis Obispo CIMIS Station
All values in inches

Calendar Year	JAN	FEB	MAR	APR	May	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1993	1.69	1.87	3.69	5.85	6.09	6.94	5.69	5.81	4.71	3.73	2.61	2.27	50.95
1994	2.36	2.31	4.03	4.80	5.21	6.89	6.02	6.10	4.38	3.82	2.43	1.90	50.25
1995	1.37	2.40	3.52	4.55	4.53	6.02	6.86	6.41	4.85	4.06	2.72	1.97	49.26
1996	2.11	1.93	3.84	5.40	6.11	6.17	6.72	6.12	4.60	3.90	2.21	1.69	50.80
1997	1.67	2.69	3.96	5.31	6.63	6.23	6.05	6.13	5.53	4.68	2.46	1.71	53.05
1998	1.76	1.74	3.64	4.58	5.15	5.68	7.12	7.08	4.97	4.45	2.81	2.64	51.62
1999	2.99	3.33	3.87	4.47	5.45	5.79	6.69	6.19	4.81	4.47	2.83	2.98	53.87
2000	2.22	1.84	3.18	4.38	5.71	5.72	5.94	5.65	4.45	3.08	2.78	2.32	47.27
2001	2.12	2.22	3.66	4.56	6.41	7.06	5.71	5.83	4.82	3.46	2.02	1.68	49.55
2002	2.22	3.11	3.72	4.42	5.79	6.43	6.78	5.72	4.85	3.38	2.80	1.61	50.83
2003	2.54	2.47	4.33	4.46	5.87	5.30	5.56	5.13	4.94	3.63	2.22	1.61	48.06
2004	2.02	2.04	4.33	5.49	6.59	6.03	5.33	5.02	4.96	3.31	2.17	2.00	49.29
2005	1.82	1.94	3.31	4.75	5.82	5.69	6.08	5.23	4.30	3.51	2.54	2.14	47.13
2006	2.06	2.81	2.66	2.89	5.14	5.75	5.94	5.24	4.35	3.59	2.82	2.44	45.69
2007	2.56	2.17	4.06	4.57	3.85	6.23	6.35	5.86	4.79	4.07	3.00	2.39	49.90
2008	1.91	2.80	4.57	5.59	5.58	6.20	6.05	5.74	4.68	4.55	2.76	2.20	52.63
2009	3.04	2.02	4.02	4.77	5.51	5.20	6.26	5.60	4.86	4.03	2.91	1.73	49.95

Table A-2. Monthly Evapotranspiration Data from Nipomo CIMIS Station
All values in inches

Calendar Year	JAN	FEB	MAR	APR	May	JUN	July	AUG	SEP	OCT	NOV	DEC	TOTAL
2006						0.58	5.47	4.57	3.49	3.33	2.67	2.15	22.26
2007	2.25	2.29	3.49	4.36	4.74	5.08	5.21	4.66	4.21	3.58	2.24	1.97	44.08
2008	1.53	2.41	3.99	5.12	4.95	5.55	4.78	4.66	3.62	3.96	2.54	1.91	45.02
2009	2.64	2.25	3.76	4.66	4.39	4.61	5.02	4.57	3.88	3.63	2.47	1.61	43.49

Appendix B
Groundwater Data

Table B-1. Groundwater Elevations October 2008 through October 2009

Well Number	Well Depth (feet)	Depth to Top of First Perforations (feet)	Ground Surface Elevation (feet MSL)	Used in October 2009 Contouring	Hydrograph Well	Sentry Well	Groundwater Elevations (feet MSL)		
							October 2008	April 2009	October 2009
10N/35W-06A02	20		75	--	--	--	63.88	64.3	59.75
10N/35W-06A01	0		75	--	--	--	63.6		
10N/35W-06A03	118		75	--	--	--	63.67		
11N/34W-29Q02	0		171	--	--	--	64.09	63.6	68.8
11N/34W-29R02	0		171	--	--	--	64.15	77.01	63.45
11N/34W-29R01	163	112	166	--	--	--	73.4		
11N/35W-26M03	700		109	--	--	--	37.28	37.6	37.35
11N/35W-28F02	48		80	--	--	--	36.93		38.35
11N/34W-27P01	0		287	--	--	--	188.8		172.88
11N/34W-27E01	0	200	305	--	--	--	119.47		113.43
11N/34W-27D01	135		296	--	--	--	225.3	225.02	222.5
11N/35W-24L03	0		325	--	--	--	13	83	-40
11N/34W-19Q01	315		306	--	--	--	32.9	47.4	32.2
11N/35W-24L02	0	440	325	--	--	--	-11	7	2
11N/34W-20J02	0		315	--	--	--	78.15	77.3	73.2
11N/35W-24J01	0	370	0	--	--	--	-282	-265	-280
11N/34W-19E01	0		0	--	--	--	-282	-280	-323
11N/35W-24A01	0		325	--	--	--	10	51	40
11N/34W-18P03	0	230	373	--	--	--	252.27	252.86	251.6
11N/35W-13E02	430	306	306	--	--	--	55.85	67.8	58.55
11N/35W-13E03	350	255	306	--	--	--	63.65	71.18	64.68
11N/35W-13D01	400		299	--	--	--	8.1	21.98	11.1
11N/34W-17B05	225		310	--	--	--	208	235	209
11N/34W-17B04	0	33	310	--	--	--	205.53	235.38	209.42
11N/35W-13C01	500		345	--	--	--	47.9	55.2	48.35
11N/34W-09P01	0		376	--	--	--	253.74	258.58	240.14
11N/35W-09K04	274		183	--	--	--	14.95	24.3	18.4
11N/35W-08L01	0		121	--	--	--	6.19	16.28	8.26
11N/35W-11J01	350	257	352	--	--	--	84.35	84.4	96.7
11N/35W-09K02	356		190.2	--	--	--	56.9	63.05	61
11N/35W-12E04	0	326	411	--	--	--	90.75	92.65	90.7
11N/35W-10G01	0	230	340	--	--	--	4.1	29.95	-3.65
11N/36W-12C01	0		19	--	Yes	Yes	12.55		
11N/36W-12C02	0	450	19	--	Yes	Yes	11.5		
11N/36W-12C03	0	720	19	Yes	Yes	Yes	7.72		
11N/35W-05R01	0	220	140	--	--	--	2.54	8.83	7.02
11N/35W-11C02	0	232	285	--	--	--	34.12	38.4	32.25
11N/35W-11C01	365	210	267	--	--	--		19.35	
11N/35W-11B01	360	315	385	--	--	--	42.36	43.6	42.5
11N/35W-05N02	0	258	100	--	Yes	--	21.25	23.4	24.7
11N/34W-05K01	180		380	--	--	--	349.7	349.8	347.42
11N/35W-06J01	0		101	Yes	--	--	19.2	21.43	18.15
11N/35W-05G02	140		135	--	--	--	2.53	11.25	4.99
11N/34W-05K02	350		400	--	--	--	157.15	290.45	171.55
11N/35W-05L01	240	192	109	--	--	--	-15.2	-6	-12
11N/35W-05L03	0		109	--	--	--	-13.48		-10.85
11N/35W-05L03	0		109	--	--	--	-13.48	-7.75	-10.85
11N/34W-05J01	0	56	390	--	--	--	366.6	374.25	346.87
11N/35W-05G01	165	250	140	Yes	--	--	16.62	25.13	17.6
11N/35W-02G01	130		400	--	--	--	305.14	305.12	304.82
11N/35W-02G02	258		400	--	--	--	180.95	181.25	180.62
11N/35W-02F01	382	352	381	--	--	--	-7.38	28.65	29.5
11N/35W-03B01	0	290	320.5	--	--	--	84.92		85.34
12N/35W-33Q02	0		340	--	--	--	132.8		
12N/35W-35P04	0		396	--	--	--	261.87		261.85
12N/35W-35P01	220		390.5	--	--	--	195.25	195.62	196.15
12N/36W-36L01	0	227	22	Yes	Yes	Yes	3.25	6.05	4.28
12N/36W-36L01	0	227	22	Yes	Yes	Yes	3.25	6.05	4.55
12N/36W-36L01	0	227	22	Yes	Yes	Yes	3.25	4.32	4.28
12N/36W-36L01	0	227	22	Yes	Yes	Yes	3.25	4.32	4.55
12N/36W-36L02	0	535	22	Yes	Yes	Yes	2.72	11.55	4.35
12N/36W-36L02	0	535	22	Yes	Yes	Yes	2.72	11.55	4.85
12N/36W-36L02	0	535	22	Yes	Yes	Yes	2.72	7.62	4.35
12N/36W-36L02	0	535	22	Yes	Yes	Yes	2.72	7.62	4.85
12N/35W-35P03	0	180	390	--	--	--	166.63	167.93	160.35
12N/35W-33J02	0	317	300.5	--	--	--	36.8	39.83	36.1
12N/35W-33L01	0	300	305	--	--	--	2.6		
12N/35W-33J03	407		270	--	--	--	-0.25	11.02	5.35
12N/35W-33E01	0		260	--	--	--	112.6		
12N/35W-32G01	0	260	190	--	--	--	0.5		
12N/34W-31F01	0		441.5	--	--	--	292		
12N/35W-35K02	0		205	--	--	--	143.77		
12N/35W-34G08	0		190	--	--	--	140.3	141.35	132.08
12N/35W-34C03	0	20	159.3	--	--	--	112.3	114.5	109.8
12N/35W-33D01	0		241	Yes	--	--	85.3	85.25	84.15
12N/35W-27N03	0	40	161.8	Yes	--	--	132.12	140.9	131.97
12N/35W-30P02	0		26.5	Yes	--	--	6.12	11.69	6.05
12N/35W-29R03	0	385	250	Yes	Yes	--	39.02	44.4	37.98
12N/35W-29N01	0	80	29	--	--	--	-2.35	6.65	0.25
12N/35W-30K04	0		26	Yes	--	--	5.34	11.9	7.93
12N/35W-30K03	0	40	31	--	Yes	--	13.6	18.75	14.48
12N/35W-30K02	0		28	Yes	--	--	5.3	11.03	6.16
12N/35W-28J02	0		181	--	--	--	132.4	132.35	
12N/35W-30M02	0		21.8	Yes	--	--	6.8	10.4	7.28
12N/35W-30M04	0		22.5	Yes	--	--	3.84	7.8	6.05

Table B-1. Groundwater Elevations October 2008 through October 2009

Well Number	Well Depth (feet)	Depth to Top of First Perforations (feet)	Ground Surface Elevation (feet MSL)	Used in October 2009 Contouring	Hydrograph Well	Sentry Well	Groundwater Elevations (feet MSL)		
							October 2008	April 2009	October 2009
32S/13E-33L02	0		42.1	Yes	--	--	1.75		3.25
32S/13E-33K03	96	64	51	Yes	Yes	--	5.08	12.2	5.85
32S/13E-31H10	0		30.48	--	--	--	2.64	2.36	1.28
32S/13E-31H10	0		30.48	--	--	--	2.64	2.36	-2.8
32S/13E-31H11	0		30.48	--	--	--	1.19	2.83	2.98
32S/13E-31H11	0		30.48	--	--	--	1.19	2.83	-1.29
32S/13E-31H12	0		30.48	Yes	--	--	-11.14	-0.84	-1.16
32S/13E-31H12	0		30.48	Yes	--	--	-11.14	-0.84	2.96
32S/13E-31H13	0		30.48	Yes	--	--	-7.24	-4.3	4.68
32S/13E-31H13	0		30.48	Yes	--	--	-7.24	-4.3	0.39
32S/13E-31H09	525	380	33.14	Yes	Yes	--	-8.21	-3.31	4.52
32S/13E-31H08	162	90	35.99	Yes	Yes	--	-1.64	4.44	1.74
32S/13E-33A05	0	18	80.5	--	--	--	47.62	57.4	58.19
32S/13E-33A06	0		80.5	Yes	--	--	28.37	36.28	25.88
32S/13E-32D03	200	114	86.33	--	Yes	--	5.18	10.5	6.44
32S/13E-32D11	607	305	86.13	Yes	Yes	--	-6.92	3.35	4.81
32S/13E-33C04	0		75	--	--	--	17.45		
32S/13E-28Q06	120		82	Yes	--	--			14.9
32S/13E-29G01	223		81.76	--	--	--	-4.24	7.76	2.21
32S/13E-28K02	101	59	86	--	Yes	--		21.82	13.89
32S/13E-30F01	802	15	17.3	--	Yes	Yes	1.77	4.92	2.97
32S/13E-30F01	802	15	17.3	--	Yes	Yes	1.77	5.63	2.97
32S/13E-30F02	802		17.3	--	Yes	Yes	1.96	5.02	2.94
32S/13E-30F02	802		17.3	--	Yes	Yes	1.96	2.96	2.94
32S/13E-30F03	802	305	17.3	Yes	Yes	Yes	-5.22	-0.38	3.12
32S/13E-30F03	802	305	17.3	Yes	Yes	Yes	-5.22	-0.16	3.12
32S/13E-30N01	873	15	10.6	--	Yes	Yes	3.41	4.57	4.07
32S/13E-30N01	873	15	10.6	--	Yes	Yes	3.41	4.57	4
32S/13E-30N01	873	15	10.6	--	Yes	Yes	3.41	4.77	4.07
32S/13E-30N01	873	15	10.6	--	Yes	Yes	3.41	4.77	4
32S/13E-30N02	873		10.6	Yes	Yes	Yes	-1.98	5.45	3.22
32S/13E-30N02	873		10.6	Yes	Yes	Yes	-1.98	5.45	2.78
32S/13E-30N03	873	60	10.6	--	Yes	Yes	2.77	5.53	3.97
32S/13E-30N03	873	60	10.6	--	Yes	Yes	2.77	5.53	4.04
32S/13E-30N03	873	60	10.6	--	Yes	Yes	2.77	4.27	3.97
32S/13E-30N03	873	60	10.6	--	Yes	Yes	2.77	4.27	4.04
32S/13E-29E07	0		60.5	--	--	--	10.5	-4.5	-49.4
32S/13E-29G02	223	103	87.86	--	--	--		9.86	2.41
32S/13E-29E02	180		60.86	Yes	--	--	5.86	10.86	5.86
32S/13E-29F01	200	22	73.35	--	--	--	3.35	8.35	3.6
32S/13E-19Q02	500	150	59	Yes	--	--	5.8	-1.1	4.3
32S/13E-23M07	0		150	--	--	--		123.73	119.1
32S/12E-24B01	964	48	7.2	Yes	Yes	Yes	2.48	5.59	4.92
32S/12E-24B01	964	48	7.2	Yes	Yes	Yes	2.48	3.62	4.92
32S/12E-24B02	964	120	7.2	Yes	Yes	Yes	2.51	2.46	4.94
32S/12E-24B02	964	120	7.2	Yes	Yes	Yes	2.51	3.85	4.94
32S/12E-24B03	964	270	7.2	Yes	Yes	Yes	3.92	4.02	6.6
32S/12E-24B03	964	270	7.2	Yes	Yes	Yes	3.92	4.02	6.39
32S/12E-24B03	964	270	7.2	Yes	Yes	Yes	3.92	4.37	6.6
32S/12E-24B03	964	270	7.2	Yes	Yes	Yes	3.92	4.37	6.39
32S/13E-14R02	0	83	198.1	--	--	--		143.65	134.95
32S/13E-14R01	0		198	--	--	--		143.6	133.6
32S/13E-13M01	22		219	--	--	--		210.75	209.98
32S/13E-12P04	0	100	240	--	--	--		214.93	213.7
32S/13E-12F05	0	13	251	--	--	--		218.9	224.35
32S/13E-12C03	0	36	271	--	--	--			246.3
11N/34W-17A02	0	140	320	--	--	--	197	239.36	272
11N/35W-09K05	0	220	180	--	--	--	-31	-8.36	-26.84
11N/35W-10G05	0		291	--	--	--	-23	-60	-72.4
11N/35W-10J02	0	330	320	--	--	--	-125	-16.8	-96.94
11N/35W-10L01	0		240	--	--	--	-72	-60.5	-111.32
11N/35W-13G01	0		311	--	--	--	-56	24	-47
11N/35W-13M02	0		300	--	--	--	-24	16	-4
11N/35W-14E01	0	380	246	--	--	--	-32	11.22	
11N/35W-14J01	0		301	--	--	--	23	44	29
11N/35W-26M02	324		107	--	--	--			35.35
32S/13E-12Q03	0		223	--	--	--		197.38	195.65
32S/13E-17K01	0		119	--	--	--	39	79	-18
32S/13E-28L01	0		80	--	--	--	-18.64		
32S/13E-29E01	0		56.1	--	--	--	-4.6	-4.6	-18.5
32S/13E-29G14	0	92	84.31	--	--	--	-0.19	7.31	2.26
32S/13E-29G15	0	290	87.73	--	--	--	-2.52	4.73	2.28
32S/13E-29G17	137		87.07	--	--	--	1.07	10.07	3.12
32S/13E-32D10	0		80.78	--	--	--	-0.65	4.86	-0.85
32S/13E-32L07	0		20.5	--	--	--	4.17		
32S/13E-33M02	0		40	--	--	--	3.13	11.55	6.3

Appendix C
Conservation Measures

MANDATORY WATER CONSERVATION MEASURES TAKE EFFECT

The City of Arroyo Grande is currently in a "Severely Restricted Water Supply Condition," which is defined as consuming 95% to 99% of annual available supply. Under the provisions of the Arroyo Grande Municipal Code, Chapter 13.05, the following restrictions on all households now take effect:

- **Use of water which results in excessive gutter runoff is prohibited.**
- **No water shall be used for cleaning driveways, patios, parking lots, sidewalks, streets or other such use except where necessary to protect the public health and safety.**
- **Outdoor water use for washing vehicles shall be attended and have hand-controlled watering devices, typically including spring-loaded shutoff nozzles.**
- **Outdoor irrigation is prohibited between the hours of 10:00 a.m. and 4:00 p.m.**
- **Irrigation of private and public landscaping, turf areas and gardens is permitted at even-numbered addresses only on Mondays and Thursdays and at odd-numbered addresses only on Tuesdays and Fridays.**
- **No irrigation of private and public landscaping, turf areas and gardens is permitted on Wednesdays. Irrigation is permitted at all addresses on Saturdays and Sundays.**
- **In all cases, customers are directed to use no more water than necessary to maintain landscaping.**
- **Emptying and refilling swimming pools and commercial spas are prohibited except to prevent structural damage and/or to provide for the public health and safety.**
- **Use of potable water for soil compaction or dust control purposes in construction activities is prohibited.**

The City's Water Conservation Program also provides assistance to residents to reduce water consumption. Public education materials are available. Low-flow toilets and showerheads will be installed at no cost to homes built prior to 1992. In addition, rebates will soon be offered for landscaping retrofits to reduce turf and increase efficiency of irrigation systems. Announcements will be mailed to all households within the next few months. Meanwhile, the City is also moving forward aggressively with efforts to increase water supply.

If you have questions regarding water conservation regulations or would like to participate in the retrofit program, please contact the Public Works Department at 473-5440.

City of Arroyo Grande
Water Conservation Incentive Programs

Despite the recent rains, the City of Arroyo Grande's water supply remains insufficient to meet the community's future needs. Therefore, conservation efforts are necessary to help avoid the need for costly new water projects and facilities. The City of Arroyo Grande is offering three new incentive programs to assist residents to conserve water, while reducing your water bills. Special requirements apply depending on the program.

1. ***Water Efficient Washing Machine Rebate Program:***
   - Rebate: $100 (Tier 2) or $150 (Tier 3). See www.waterenergysavings.com for qualifying washers.
   - Washer must be purchased on or after February 1, 2009.
   - Purchase must be made within the City of Arroyo Grande (Ruffoni's Home Appliance Center or Kmart).

2. ***"Cash For Grass" Rebate Program:***
   - Rebates are based on the square footage of turf removed. Under this program, turf must be replaced with drought tolerant plants and sprinklers must be replaced with drip irrigation.
   - To qualify for the reimbursement, a City inspection must be conducted prior to and after the turf removal.
   - Reimbursements are based upon the following criteria:

Rebate Amount	Amount of Grass Removed
$75	250 - 500 sq. ft.
$150	500 - 1,500 sq. ft.
$300	1,500 – 2,500 sq. ft.
$450	2,500 – 3,500 sq. ft.
$600	3,500 – 4,500 sq. ft.
$750	4,500 and up

3. ***Smart Irrigation Controller & Sensor Program:***
   - Smart Irrigation Controllers and Sensors (*Baseline WaterTec S100 and Hunter Solar Sync*) are available at no charge to eligible customers to encourage residents to upgrade their old irrigation controllers with new weather-based sensor technology. These state-of-the-art irrigation controllers and sensors help to conserve water, save money and reduce runoff by automating landscape watering based on the weather, site conditions and water needs of plants.

Free Workshop!

To assist residents with understanding, installing and programming Smart Irrigation Controllers, the City is offering a free workshop. Here are the details:

- **Date:** ***Saturday April 18, 2009***
- **Time:** ***10:00 AM – 12:00 PM***
- **Location:** ***Arroyo Grande City Council Chambers***
  215 E. Branch Street

Applications for these programs are available at City Hall (214 E. Branch Street) and the Public Works Department (208 E. Branch Street). For questions about this program, please contact Kelly Heffernon in the Public Works Department at (805) 473-5447.