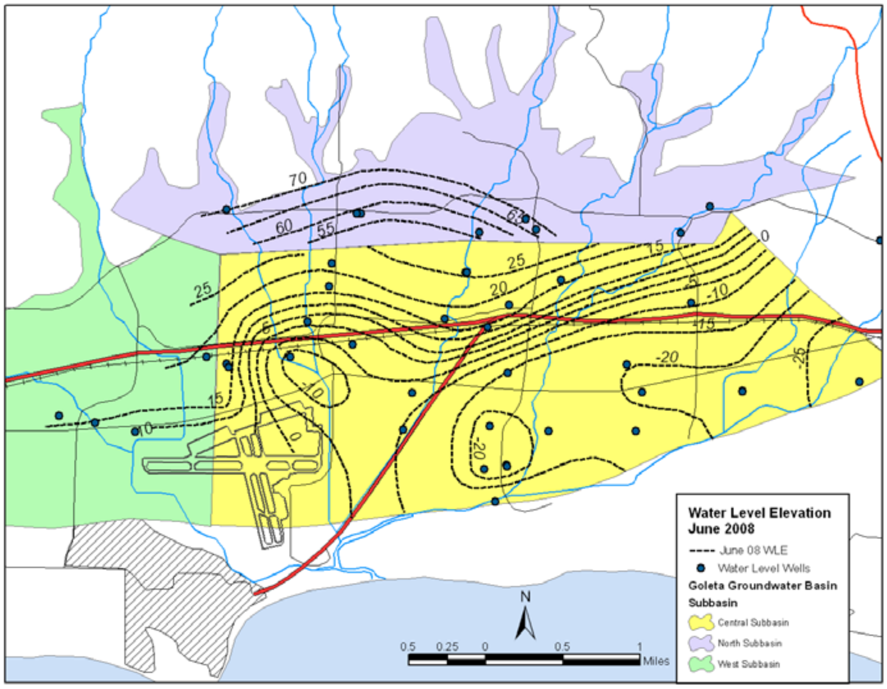
Groundwater Management Plan

Goleta Groundwater Basin

Final



Prepared for

Goleta Water District

La Cumbre Mutual Water Company

By
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May 11, 2010

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1 Introduction

Goleta Water District ("GWD") and La Cumbre Mutual Water Company ("La Cumbre"), the purveyors of groundwater in the Goleta Groundwater Basin (Figure 1-1), joined in developing a Groundwater Management Plan ("Plan") for the basin. This Plan reiterates current adjudication and voter-passed components of groundwater management, addresses groundwater issues, adopts Basin Management Objectives, outlines management strategies for the basin, and recommends future tasks and timelines associated with these tasks.

The process of preparing and adopting the Plan included public meetings with input from stakeholders, public drafts circulated for comments, and adoption by both water purveyors.

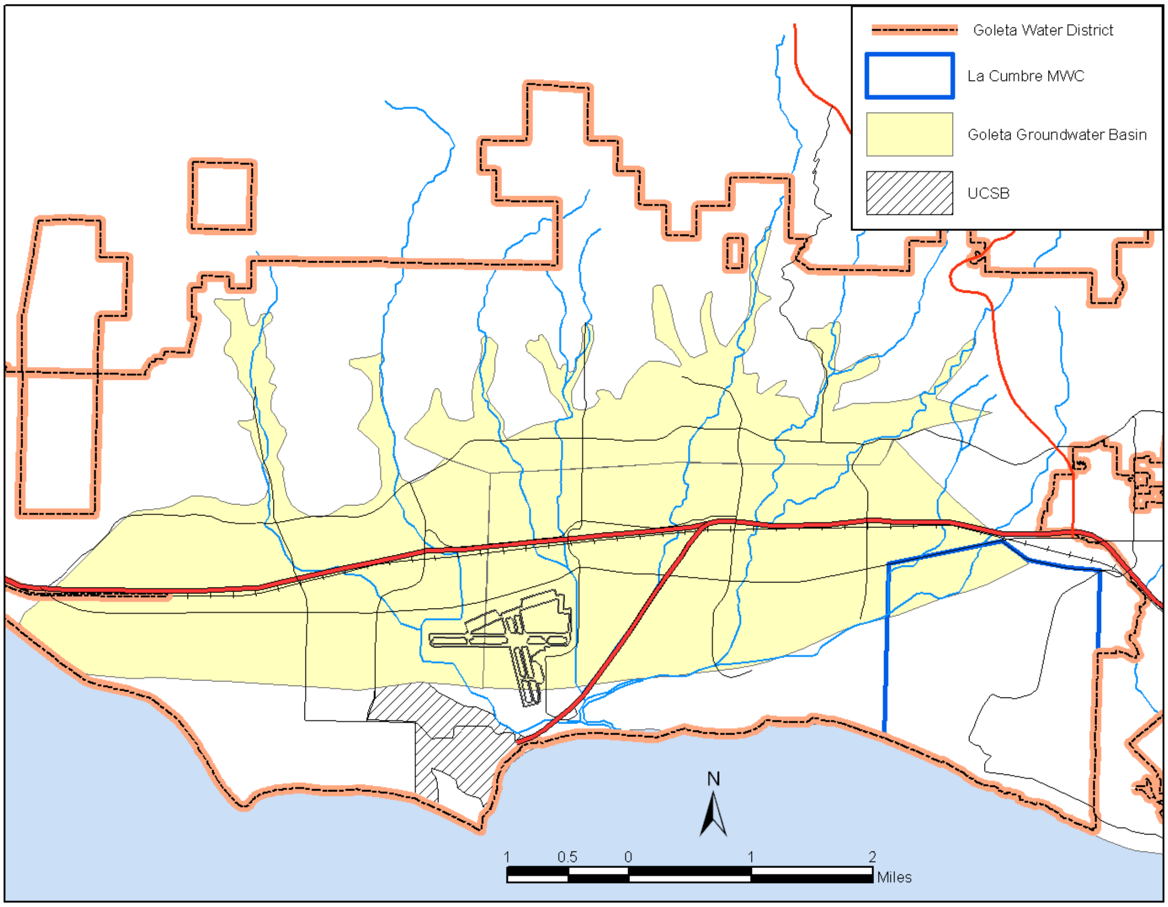

Figure 1-1. Goleta Groundwater Basin with service areas of Goleta Water District and La Cumbre Mutual Water Company.

1.1 Pre-Wright Judgment

As the result of a long period of drier than average years from the 1940s to the 1970s, coupled with growth in the area, water supplies in the Goleta Groundwater Basin were considered to be short of demand by the 1970s. As a result, GWD adopted various rules and regulations to restrict the use of water. First, GWD adopted Ordinance 72-2, which began a moratorium on new water service connections. The Ordinance was modified over the years to make exceptions for fire hydrant flow and service connections that would result in water savings to GWD. This moratorium remained in effect until December 1996, when Ordinance 96-4 rescinded it following the importation of State Water. Ordinance 72-2 was for the most part superseded by the Responsible Water Policy Ordinance which was adopted in May 1973 by voter initiative. This Ordinance banned the importation of water from outside the County without voter approval, which was largely aimed at preventing GWD from connecting to the State Water Project. As a result of these actions, considerable emphasis was placed on pumping groundwater, so significant pumping in the basin continued.

1.2 Wright Judgment

In 1973 a group of landowners filed suit for the adjudication of water rights in the Goleta North-Central Groundwater Basin (Wright v. Goleta Water District[1]). As is common in groundwater adjudications, after cross complaints and an appeal, the case took two decades to be decided; the decision was finalized in 1989 (“Wright Judgment”). The major elements of the Wright Judgment dealing with groundwater management include:

- Overlying landowners assured of superior rights to groundwater pumping; overlying pumping determined to be 351 acre-feet per year, which can increase without Court approval as long as there is no change in how the pumped groundwater would be used (e.g., change of use would be conversion of agricultural to urban use);
- La Cumbre given senior appropriative right to extract 1,000 acre-feet per year from basin (calculated on a ten-year running average), plus any Temporary Surplus[2];
- GWD given appropriative right to extract 2,000 acre-feet per year from basin, plus any Temporary Surplus;
- Safe yield of the basin was determined to be 3,410 acre-feet per year;
- Perennial yield, which included 350 acre-feet per year for GWD injection well system and 100 acre-feet per year of return flow (applied water that percolates back to the aquifer), was determined to be 3,700 acre-feet per year;
- GWD required to submit to Court a Water Plan, including development of supplemental supplies, whose objective was to bring the basin into hydrologic balance by 1998;
- Status report on the basin to be filed with the Court on an annual basis;

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[1] Martha H. Wright et al. v. Goleta Water District et al., 1989, Amended Judgment, Superior Court of Santa Barbara County Case No. SM57969.

[2] Temporary Surplus is defined in the Judgment as “The amount of water that can be extracted from the Basin in any Water Year in excess of the Basin's Safe Yield”.

- Overlying pumpers may transfer their water right and well(s) to GWD in return for service from GWD. Such exchanges have added 350 acre-feet per year of water rights to GWD as of 2008 (Table 1-1);
- GWD may inject water into the basin using La Cumbre wells until 1998; after 1998, La Cumbre and GWD may each store water in the basin;
- Court assumes continuing jurisdiction in the basin.
- In 1992, the Court reaffirmed the continuing right of GWD to store up to 2,000 acre-feet per year in the basin[3].
- In 1998, the Court found that the basin was in Hydrologic Balance[4] and that summary annual reports to litigation parties could replace annual reports to the Court[5]. It also confirmed GWD's storage of 18,084 acre-feet as of 1998.

Year	*Base Water Right (AFY)*	*Exchanges To-Date (AFY)*	*Total Water Right (AFY)*
1992	2,000	23	2,023
1993	2,000	37	2,037
1994	2,000	51	2,051
1995	2,000	51	2,051
1996	2,000	175	2,175
1997	2,000	224	2,224
1998	2,000	226	2,226
1999	2,000	226	2,226
2000	2,000	226	2,226
2001	2,000	226	2,226
2002	2,000	226	2,226
2003	2,000	350	2,350
2004	2,000	350	2,350
2005	2,000	350	2,350
2006	2,000	350	2,350
2007	2,000	350	2,350
2008	2,000	350	2,350
2009	2,000	350	2,350

Table 1-1. GWD water rights under the Wright Judgment, as filed in GWD's Annual Reports.

As a result of the Wright Judgment, GWD was required to annually file a report to the Court. In 1998, the Court determined that the GWD had achieved Hydrologic Balance as that term is defined in the Judgment, had successfully complied with the Judgment, and allowed GWD to simplify the report and to no longer file it with the Court

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[3] Martha H. Wright et al. v. Goleta Water District et al., 1992, Order Regarding Goleta's Right to Store Water in the North Central Basin, Superior Court of Santa Barbara County Case No. SM57969.

[4] As it pertains to the basin as a whole, Hydrologic Balance exists when the perennial recharge exceeds the perennial extractions from the basin.

[5] Martha H. Wright et al. v. Goleta Water District et al., 1998, Order Regarding Goleta Water District's Tenth Annual Report, Superior Court of Santa Barbara County Case No. SM57969.

but send it to the various parties in the litigation. This report itemizes extractions from the basin, groundwater storage, and changes in groundwater elevations from key wells. GWD has stored water in the basin by direct injection, as well as by taking Cachuma water and its State Water allocation in lieu of pumping groundwater, resulting in 42,530 acre-feet of stored water by 2008 (see Section 4.4.1 – *Groundwater Storage Programs* for details).

1.3 SAFE Ordinance (GWD)

As part of authorization for importation of State Project Water, the Safe Water Supplies Ordinance ("SAFE") was approved by GWD voters in 1991 and amended in 1994[6]. SAFE amended and superseded the Responsible Water Policy Ordinance. The key elements of SAFE include:

- The GWD is authorized to acquire an additional entitlement to the State Water Project in an amount of up to 2,500 acre-feet per year to supplement its allocation of 4,500 acre-feet per year;
- The GWD shall plan for the delivery of 3,800 acre-feet per year of State Water as the amount of firm average long-term yield (this was based on the then-current availability calculations by the State Water Contractors), which includes the basic allocation of 4,500 acre-feet per year, the 2,500 acre-feet per year supplement, and GWD's share of the drought buffer held by the Central Coast Water Authority;
- Any excess water actually delivered over 3,800 acre-feet per year shall be stored in the Central subbasin until the basin is replenished to its 1972 level, for use during drought conditions ("Drought Buffer"). An "Annual Storage Commitment" of at least 2,000 acre-feet per year is required for replenishment to 1972 levels (first instituted in 1997). As of 2008, a total of 42,530 acre-feet of water have been added to basin storage through direct injection and using other water supplies in lieu of pumping groundwater (GWD, 2008);
- The Drought Buffer can only be used for delivery to existing customers when a drought on the South Coast causes a reduction in GWD's annual deliveries from Lake Cachuma, and cannot be used as a supplemental supply for new or additional water demands;
- Once the basin has recovered to 1972 levels, GWD can again utilize the yield of the basin to provide water service to existing customers. It has been estimated that in 2008, storage in the Central subbasin is 6,000 to 12,000 acre-feet above 1972 levels (GWD, 2008). Storage is discussed further in this Plan;
- For each year that all other obligations for water delivery have been met, GWD may provide new service connections up to 1% of the total potable water supply. When new service is connected, the Annual Storage Commitment for the Drought Buffer must permanently increase by ⅔ of the

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[6] GWD Ordinances No. 91-01 and 94-03.

new demand. The requirements for new service connections have been met over the last decade, with new service connections adding 559 acre-feet per year of demand, resulting in an increase of the Annual Storage Commitment to 2,373 acre-feet per year.

2 Groundwater Basin and Hydrogeology

2.1 Basin Boundaries

The Goleta Groundwater Basin is generally divided into three subbasins: the Central subbasin where the majority of the extractions occur; the West subbasin which is generally shallower and has the least extractions; and the North subbasin. The boundaries for these subbasins and for the Goleta basin as a whole vary among investigators. Some of the boundaries coincide with faults that are mapped at the surface or are inferred from hydrogeologic evidence such as large differences in groundwater elevations on each side of the "fault". Other boundaries are defined by the thinning edges of water-bearing strata against bedrock highs and upstream valleys. Because of the differences in interpretations of this evidence, basin and subbasin boundaries have been drawn differently.

2.1.1 Boundary of Overall Basin

There are common boundaries among investigators in portions of the basin. The southern boundary of the Goleta Groundwater Basin is defined by the trace of the More Ranch Fault (Figure 2-1), where consolidated rocks of Tertiary age are uplifted along the south side of the fault and form a hydrologic barrier between the ocean and the water-bearing deposits of the ground-water basin (e.g., Upson, 1951). The location of the More Ranch Fault has varied slightly among investigators; for this Plan, the location of the fault (and, therefore, the southern boundary of the groundwater basin) is taken from the latest U.S. Geological Survey ("USGS") mapping (Minor and others, 2006).

The eastern boundary of the Goleta Groundwater Basin has historically been defined as the location of the Modoc Fault. The Modoc Fault has been considered to be a hydrologic barrier, although the USGS suggested that along the eastern boundary near its southern juncture with the More Ranch fault, groundwater discharges freely from the adjacent Foothill Groundwater Basin on the east into the Goleta Groundwater Basin (Freckleton, 1989).

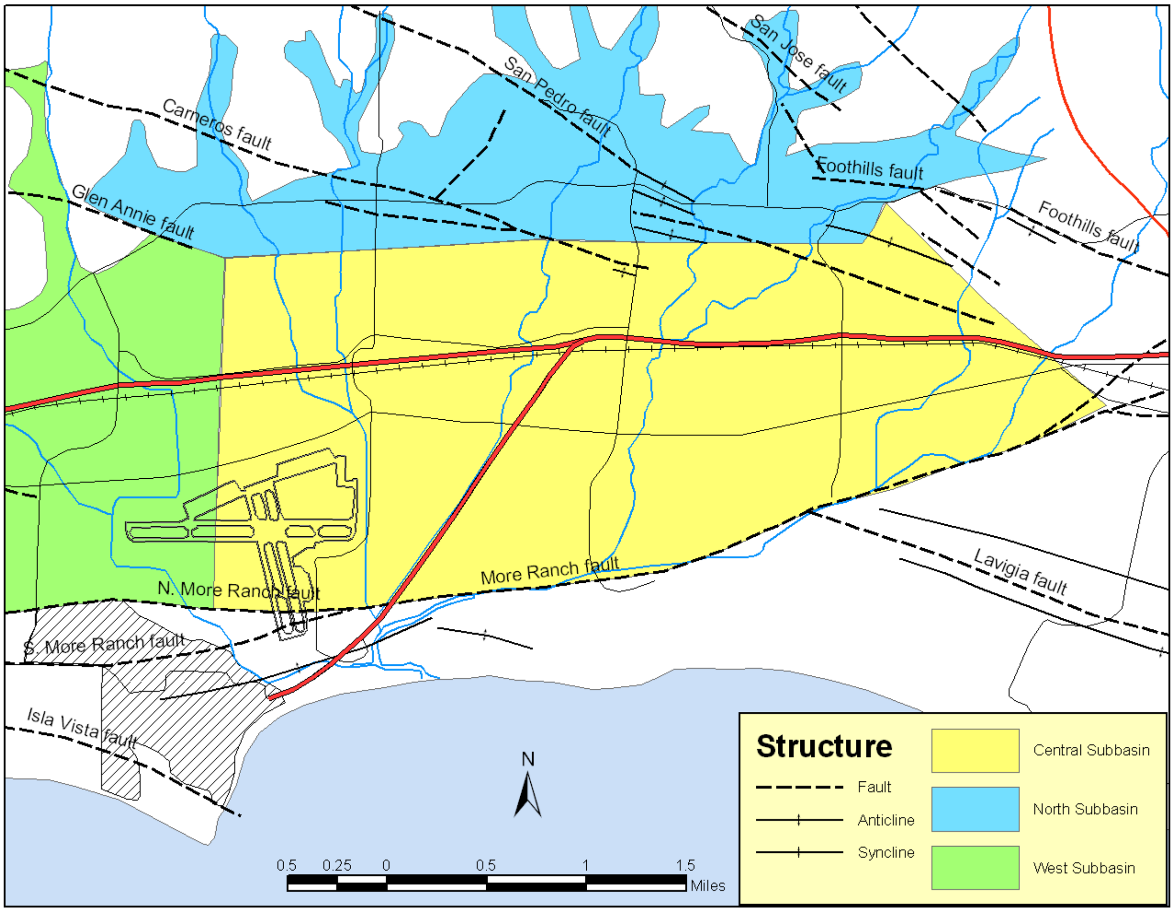


Figure 2-1. Basin and subbasin boundaries used in this Plan. Faults and folds are from Minor and others (2006).

Upson (1951) determined the location of the barrier on the basis of differences in water-level altitudes and the lack of transmission of pumping effects across the fault. Upson (1951), Evenson and others (1962), and Mann (1976) indicated that the quantity of ground water moving across the boundary historically has been small. The USGS also considered the eastern boundary of the basin as the Modoc Fault in a water resources paper (Kaehler and others, 1997), although a more-recent surface geology map by the USGS (Minor and others, 2006) did not identify the Modoc Fault – instead they identified faults and folds across a half mile-wide deformation zone that encompasses the various locations of the boundary by a number of investigators (Figure 2-1). There are no known groundwater wells within this zone of deformation. The eastern basin boundary in the Wright Judgment is within this zone of faulting and folding. For this Plan, the Wright Judgment boundary is considered as the eastern basin boundary.

The northern boundary of the Goleta Groundwater Basin has been defined by the northern edge of water-bearing sediments as they abut or thin out against older more-consolidated sediments. The exact location of the boundary varies with the investigator. For this Plan, the northern basin boundary from the Wright Judgment is used as far as it extends to the west; west of the Wright Judgment, the basin boundary of CH2MHill (2006) is used.

2.1.2 Subbasin Boundaries

The boundaries between subbasins within the Goleta Groundwater Basin have been defined by either the location of suspected faulting or by changes in hydrologic properties across the boundary (Figure 2-1). None of the subbasin boundaries coincide with surface traces of faults mapped by the USGS (e.g., Minor and others, 2006).

Upson (1951) stated that the "Goleta Fault" and extensions of the Carneros and Glen Annie faults all inhibit the movement of ground water in the main aquifers in the basin. He located the east-west trending boundary on the basis of differences in water levels and lack of transmission of pumping effects across the inferred trace at several sites. Evenson and others (1962) proposed a slightly different location and stated that groundwater moves across this hydrologic barrier in the upper part of the groundwater system. The subbasin boundary in the Wright Judgment largely follows that of Evenson and others. The subbasin boundary was subsequently moved about a thousand feet farther south in reports to the Goleta Water District (e.g., CH2MHill, 2006). For this Plan, the subbasin boundary follows the most-recent interpretation by CH2MHill. However, for discussions of water rights issues, the Wright Judgment boundary must be used; this will be called out in the Plan when necessary.

The north-south-trending boundary between the Central and West subbasins is characterized by significant changes in water quality and hydraulic characteristics thought to be related to different sediment types and thicknesses (GWD, 2008). Evenson and others (1962) believed that there were differences in water levels in wells and in water level trends across the boundary. Mann (1976) documented water quality differences on opposite sides of the boundary. Evenson and others (1962) attributed the boundary to a lateral change in permeability caused by a facies change in the sediments or by faulting in the unconsolidated sediments. The location of the subbasin boundary varies among investigators by 2,500 ft in an east-west direction. The boundary used in this Plan is from the Wright Judgment because of water rights implications. However, hydrographs of wells to the east of the Wright boundary appear to be more similar to those in the West subbasin than in the Central subbasin. For this reason, the subbasin boundary in the new groundwater model is located to the east of the Wright boundary (CH2MHill, 2009b).

2.2 Basin Aquifers

The Goleta Groundwater Basin is bounded by consolidated rocks of Tertiary age. The principal water-bearing units are younger alluvium of Holocene age, terrace deposits and older alluvium of Pleistocene age, and the Santa Barbara Formation of Pleistocene age (e.g., Kaehler and others, 1997). The younger and older alluvium are generally less than 250 ft thick and the Santa Barbara Formation is as much as 2,000 ft thick.

The Santa Barbara Formation is the primary water-bearing unit in the basin and comprises primarily of marine sand, silt, and clay. The hydrostratigraphy of the basin has been divided into hydrostratigraphic zones based on geologic and geophysical logs

(CH2MHill, 2005). From youngest to oldest, the zones that produce meaningful amounts of groundwater include:

- An Upper Producing Zone consisting of alternating sequences of sands, silts, and sandy clays that attain a maximum thickness of up to 600 feet. In the Central subbasin, mostly private wells produce from this unit.
- A Lower Producing Zone of clean fine sands and silt about 200 ft thick in the Central subbasin. This Lower Zone is separated from the Upper Zone by a clay-rich aquitard. GWD and La Cumbre wells produce from this zone.

The hydraulic connection between the Upper and Lower Producing zones is not well understood. Groundwater elevations measured from wells in each zone have generally been combined when water level contours have been constructed.

2.3 Sources of Recharge

The major sources of recharge (other than artificial recharge by the water agencies) to the Goleta Groundwater Basin are likely infiltration from rainfall, percolation from streambeds, deep percolation of irrigation waters, and leakage from the adjacent (largely upslope) consolidated rocks. Recharge from surface sources can only occur if the sediments between the ground surface and the aquifer can transmit water downward. If, instead, there is a clay layer or other less-transmissive layer above the basin aquifers (a “confining layer”), then downward percolation is largely eliminated. Instead, these areas of the aquifer that are below confining layers must receive their recharge by horizontal flow within the aquifer from other areas where confining layers are absent.

In the Goleta Groundwater Basin, confining layers occur in the seaward portion of the basin. One of the areas where there is little or no communication of surface waters and aquifer waters is around the tidal channels that make up much of the seaward portion of the basin – if there was vertical communication between the tidal waters and the aquifers, groundwater would be as salty as the tidal waters. There has been disagreement among researchers as to how far the coastal confining layers extend inland. Upson (1951) considered much of the area south of Cathedral Oaks Blvd to the ocean as having confined conditions. This effectively eliminates much of the area of the basin from recharge by percolation from overlying sources. Upson estimated that an average of about 3,100 acre-feet per year of rainfall and stream infiltration reach the aquifer. In contrast, Evenson and others (1962) considered the confined area to be much smaller, increasing the area for direct recharge from surface sources.

Much of the Central subbasin is likely under confined conditions. For the subbasin to receive recharge from the adjacent North subbasin (which is largely unconfined), the proposed fault(s) that separates the subbasins must be “leaky” – that is, it is only a partial barrier to groundwater flow, allowing some groundwater to flow thorough the fault plane into the Central subbasin.

2.4 Groundwater Elevations

Groundwater elevations have been collected from wells in the Goleta Groundwater Basin since at least the 1940s. These records have now been collected and entered into digital databases for analysis. GWD also contracted a land survey of all wells used for monitoring groundwater elevations so that both the location and the elevation of the wells are known with some accuracy. Contours of water level elevations from the June 2008 measurements are shown in Figure 2-2. Note that groundwater elevations are lowest in the southeastern portion of the Central subbasin (deeper than 25 feet below sea level) and that the regional groundwater gradient is generally from north to south. This gradient reflects the movement of recharge water from the streams and outcrops on the northern side of the Goleta Groundwater Basin towards the areas where pumping is highest. The groundwater elevations vary by as much as 40 feet across the boundary between the North and Central subbasins (Figure 2-2), suggesting that the boundary is at least a partial barrier to groundwater flow.

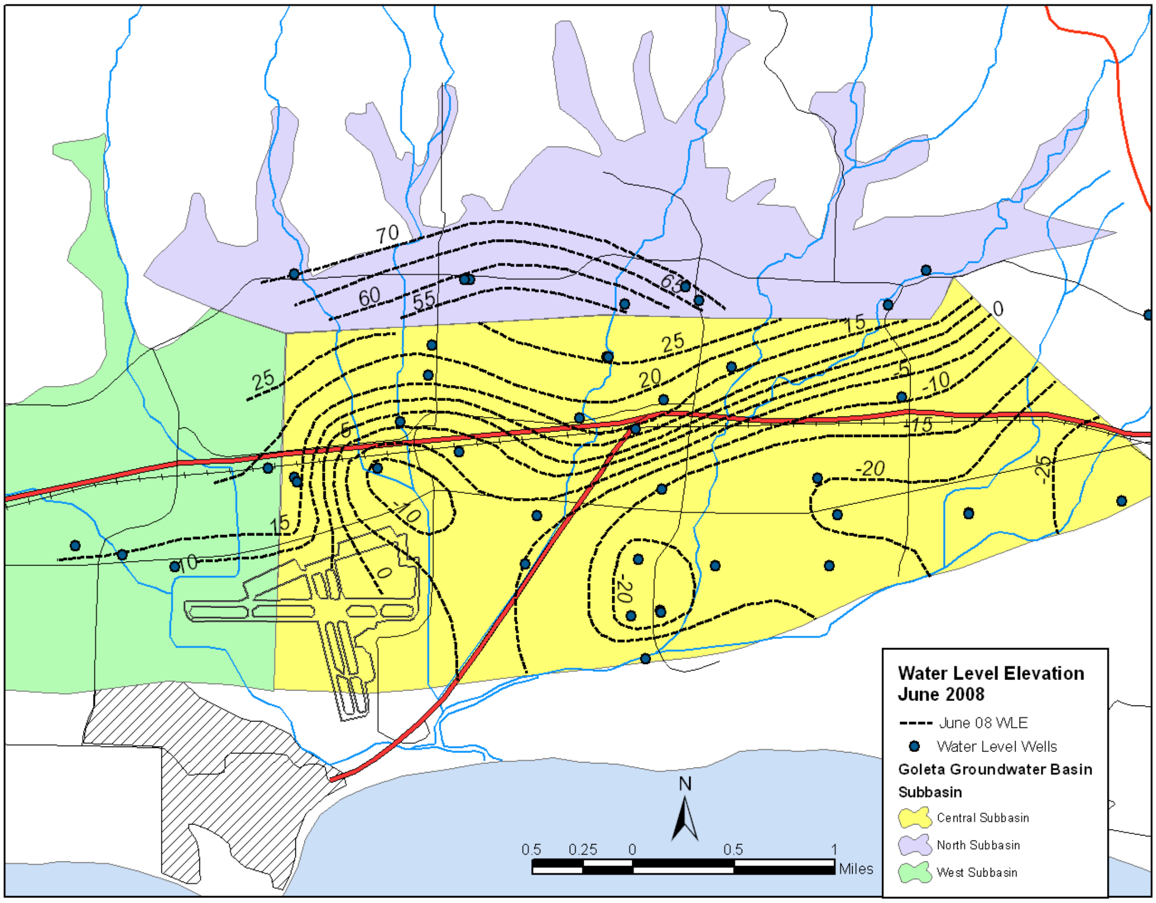


Figure 2-2. Contours of groundwater elevations for June 2008 measurements. Contour interval is 5 feet, datum is mean sea level. Wells which were measured are indicated by a dot on the map.

The analysis of groundwater elevations is subdivided into the three subbasins because each subbasin shows a different historical trend. The locations of the wells used in the hydrograph displays are indicated on Figure 2-3.

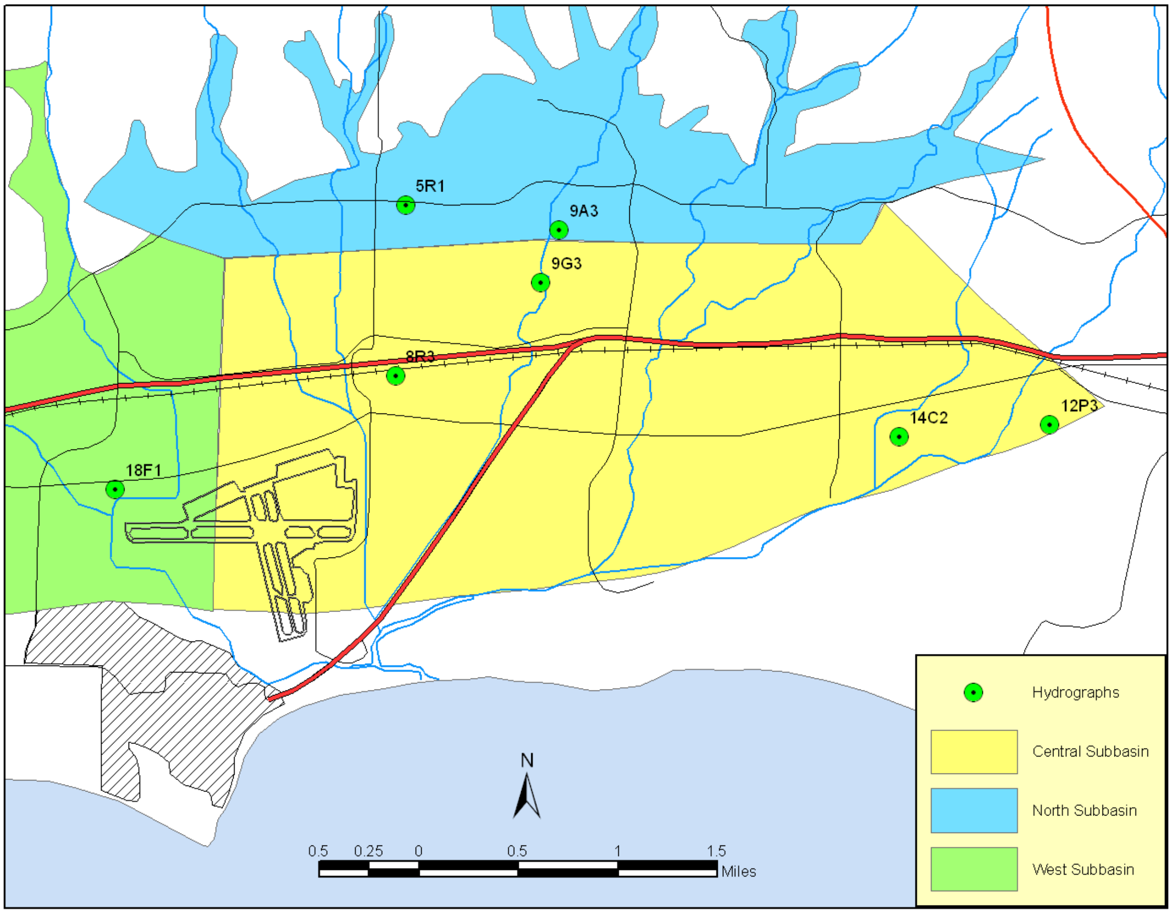


Figure 2-3. Locations of wells for which hydrographs are included in this Plan.

2.4.1 Central Subbasin

Groundwater elevations in the Central subbasin have fluctuated by almost 150 feet over the last 70 years (e.g., Figure 2-5 to Figure 2-9). The wet climatic cycle ending in the 1940s is commonly the high historical groundwater elevation in many coastal basins of California; however, in the Central subbasin, high groundwater elevations in the 1940s were matched in many wells during the early 1970s and at present. Thus, the basin is currently near or above historical high groundwater conditions.

When groundwater basins are being pumped within the yield of the basin and the primary sources of recharge to the basin are rainfall and subsequent runoff (as is the case in the Goleta Groundwater Basin), hydrographs in a basin commonly reflect the local climatic patterns. These climatic patterns can be represented by a cumulative departure curve such as shown in Figure 2-4, where the dropping slope of the line indicates periods of less rainfall and the rising slope indicates periods of abundant rainfall. For Goleta, the lowest cumulative departure occurred in the late 1960s and early 1970s.

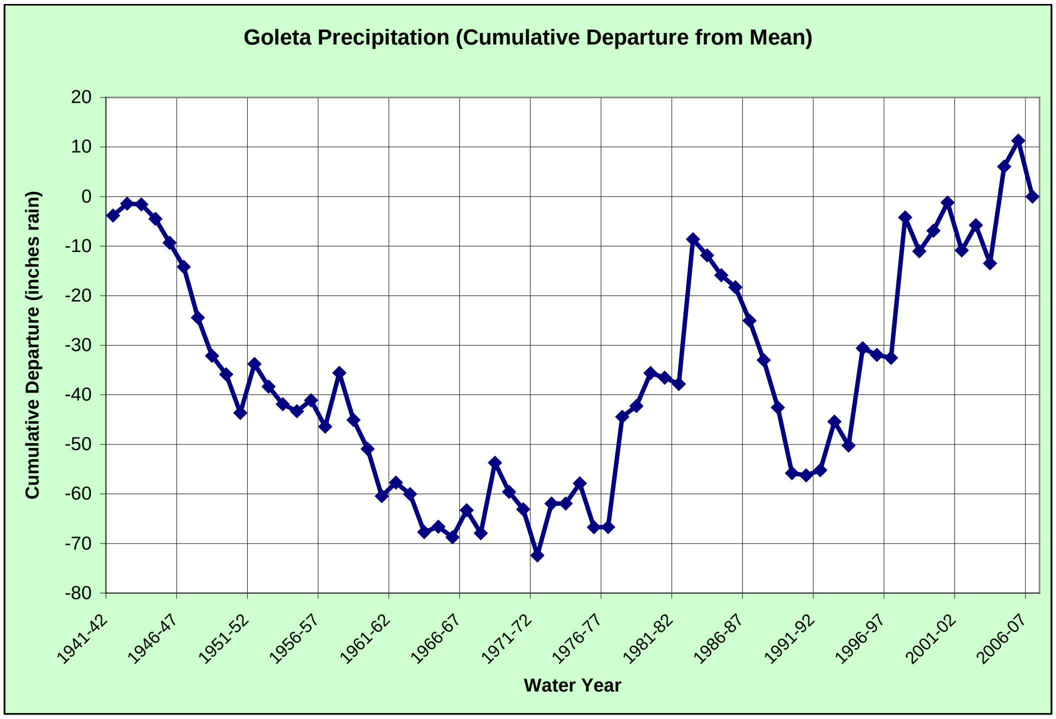


Figure 2-4. Rainfall at Goleta Fire Station #14 (Los Carneros Rd between Calle Real and Cathedral Oaks), cumulative departure from mean. Portions of the curve that are going down with time indicate periods of below-normal rainfall, whereas portions of the curve that are going up indicate periods of above-normal rainfall.

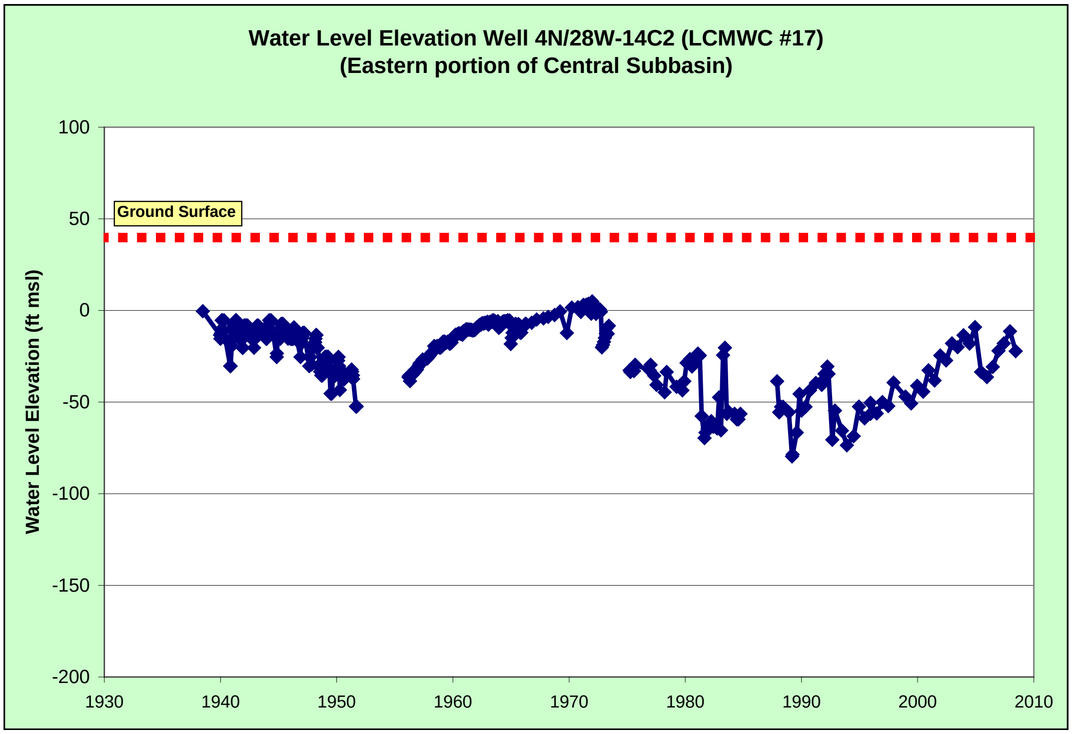


Figure 2-5. Hydrograph of well 14C2 in the eastern portion of the Central subbasin.

However, hydrographs for the Central subbasin do not track this pattern. In Figure 2-6, the cumulative departure curve is superimposed on the hydrograph for well 14C2. As indicated, the water level elevations tracked the cumulative departure into the late 1950s, but then diverged. During the late 1950s to the early 1970s, groundwater elevations were rising during drier than normal conditions. However, as rainfall increased during the 1970s to 1983, groundwater elevations dropped during that time. The climatic trend and the groundwater trend are then synchronous again for the remaining 25 years. This pattern generally suggests that the Central subbasin was pumped less than its yield before 1972, above its yield in the 1970s and early 1980s, and within its yield since that time.

Although groundwater elevations are near historical high in the Central subbasin, they are well below land surface elevation and below sea level. Groundwater elevations below sea level in coastal basins that abut the ocean are always a concern because of the potential for seawater intrusion into the aquifer. Unfortunately, there are examples of seawater intrusion caused by low groundwater elevations in Orange, Los Angeles, Ventura, San Luis Obispo, and Monterey counties. As discussed in section 2.1 - *Basin Boundaries*, the More Ranch Fault apparently provides protection from seawater intrusion by uplifting a block of older material across what could be a pathway for seawater to move inland in the aquifer. This is not unprecedented in coastal basins – the Newport-Inglewood Fault provides similar protection along the Orange and Los Angeles counties' coastline, except in areas where buried canyons cut through the older sediments in the uplifted fault block.

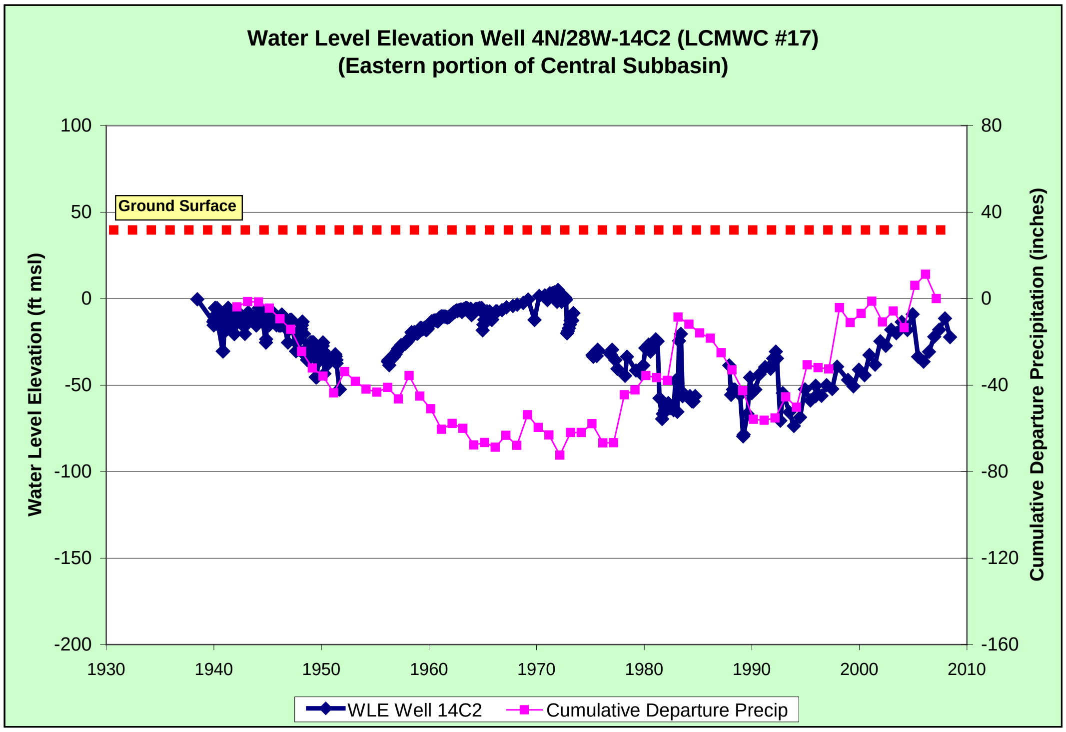


Figure 2-6. Same as Figure 2-5, except cumulative departure for rainfall from Figure 2-4 is superimposed on hydrograph.

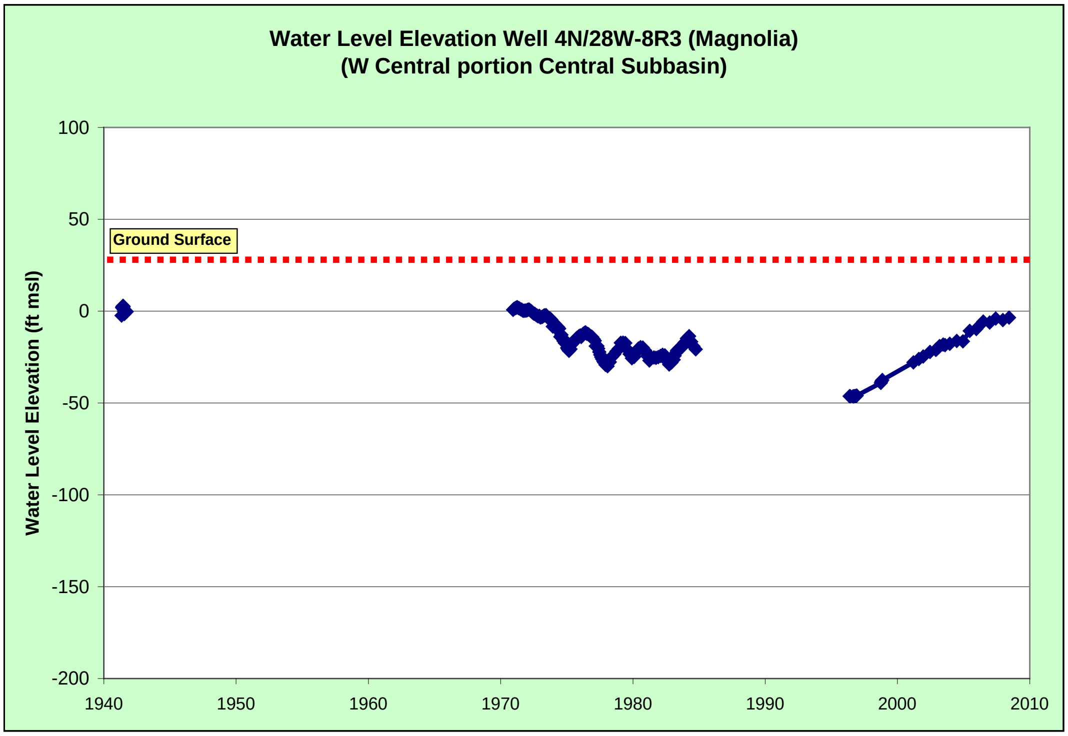


Figure 2-7. Hydrograph of well 8R3 in the western portion of the Central subbasin.

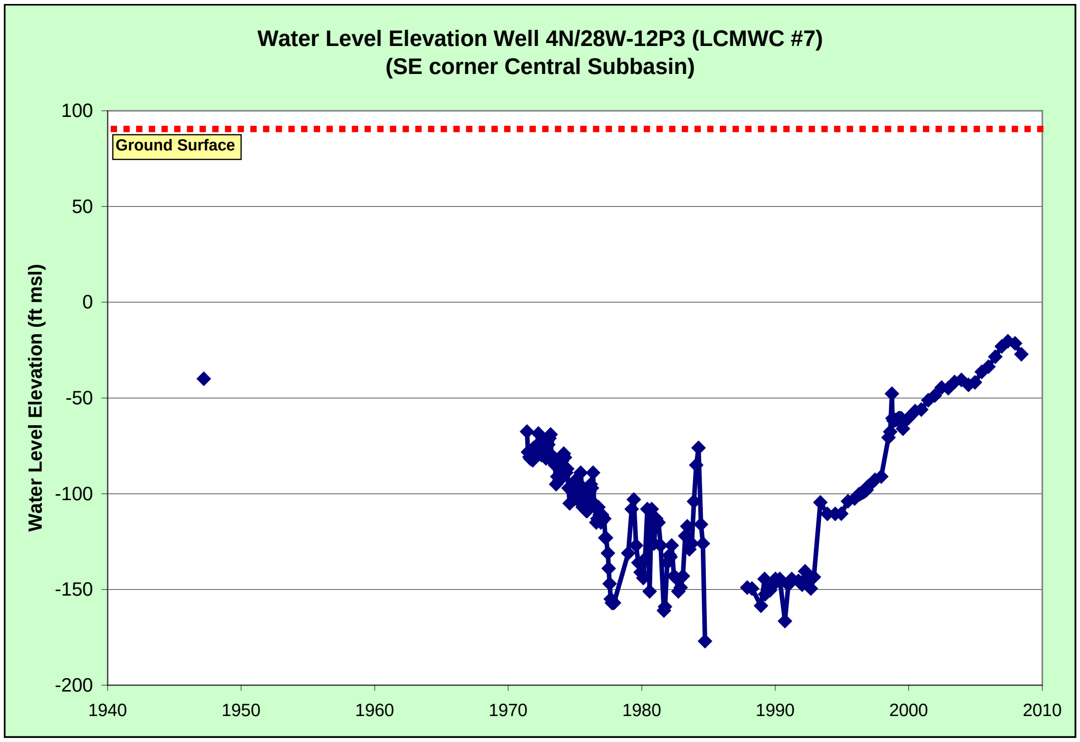


Figure 2-8. Hydrograph of well 12P3 in far southeastern corner of Central subbasin.

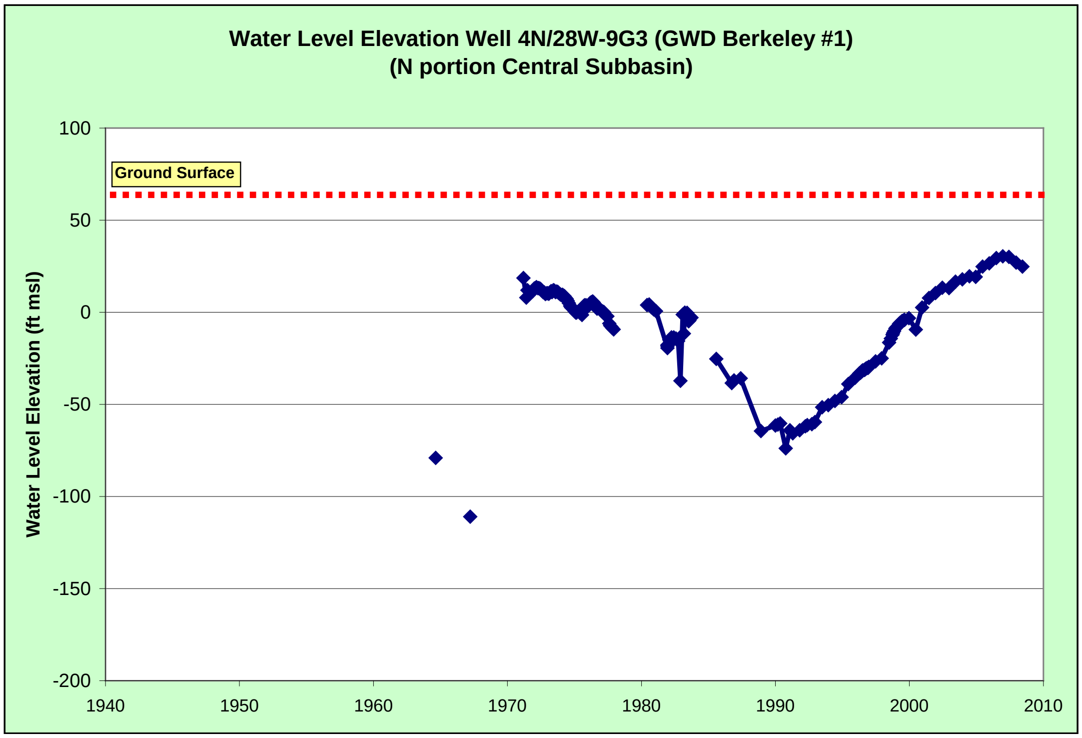


Figure 2-9. Hydrograph of well 9G3 in northern portion of Central subbasin.

2.4.2 North Subbasin

Groundwater elevations have generally fluctuated within a narrower range in the North subbasin than in the Central subbasin (Figure 2-10 and Figure 2-11). The overall trend in groundwater elevations is similar to the Central subbasin, with groundwater highs in the 1970s and today and a groundwater low in the early 1990s. Groundwater elevations are generally above sea level and have approached land surface in some wells.

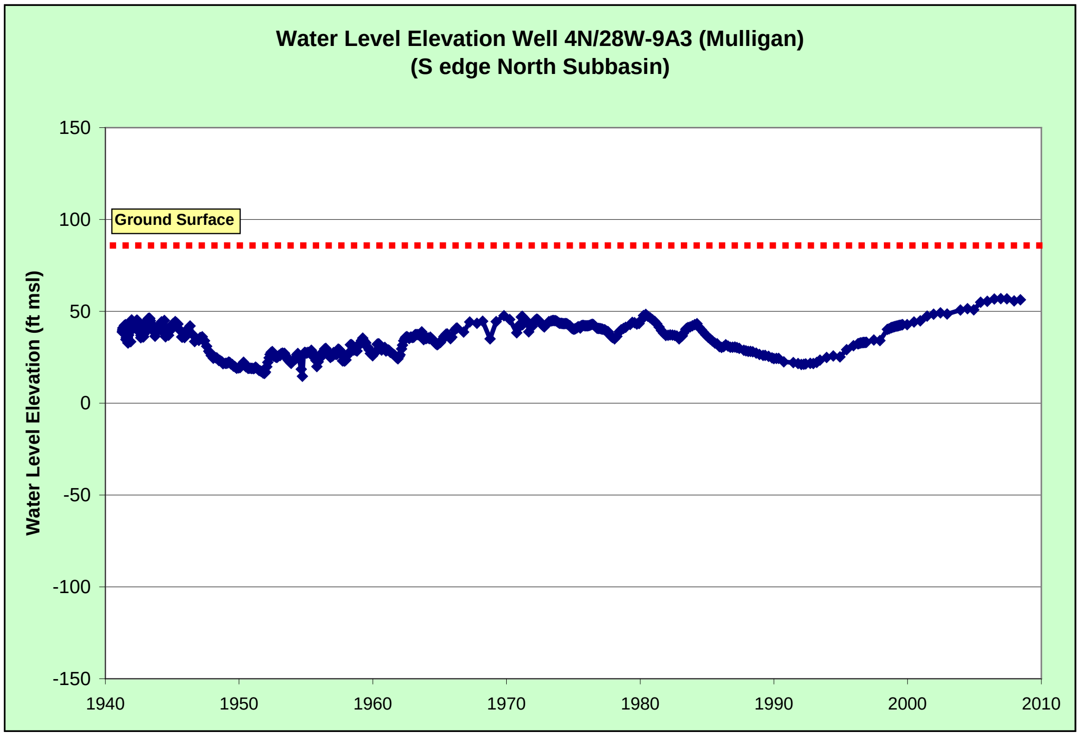


Figure 2-10. Hydrograph of well 9A3 along the southern edge of the North subbasin.

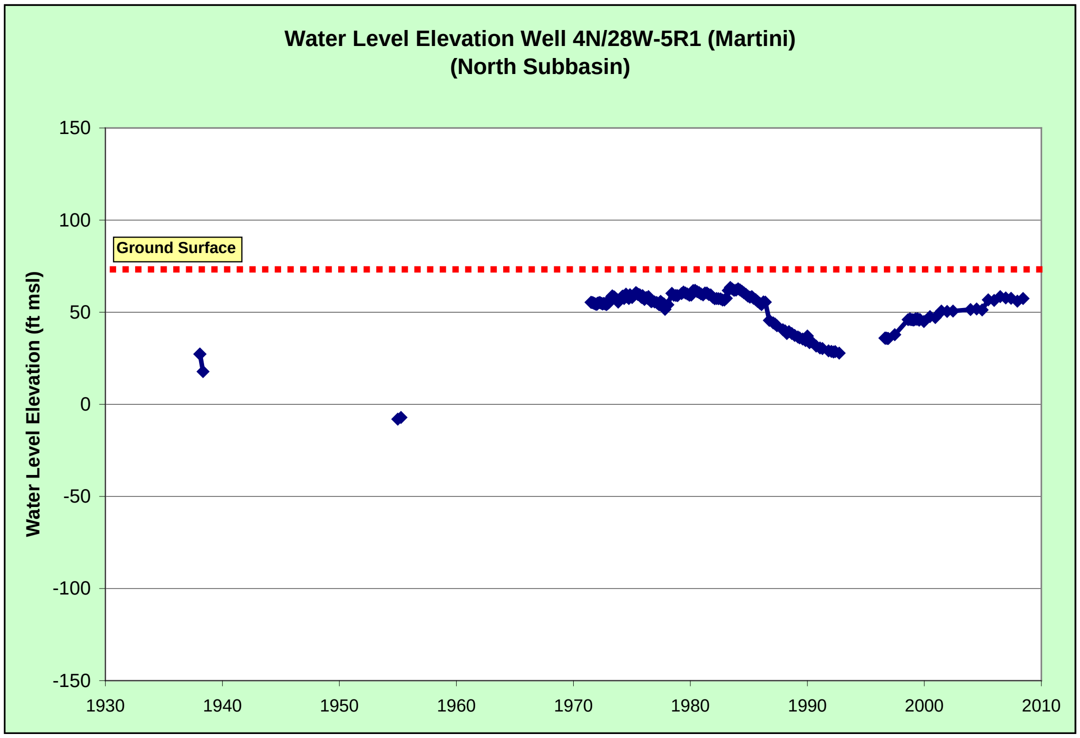


Figure 2-11. Hydrograph of well 5R1 in the North subbasin.

2.4.3 West Subbasin

Although groundwater elevations in historical records have dropped below ground surface, groundwater elevations today are very near the surface (e.g., Figure 2-12). When groundwater elevations are this high, they can create springs and boggy areas, as well as causing problems to the foundations of buildings. CH2MHill (2009a) reported local problems caused by the high groundwater elevations. It is likely that the current high groundwater elevations were the natural condition in the West subbasin, but may not be appropriate in a managed basin.

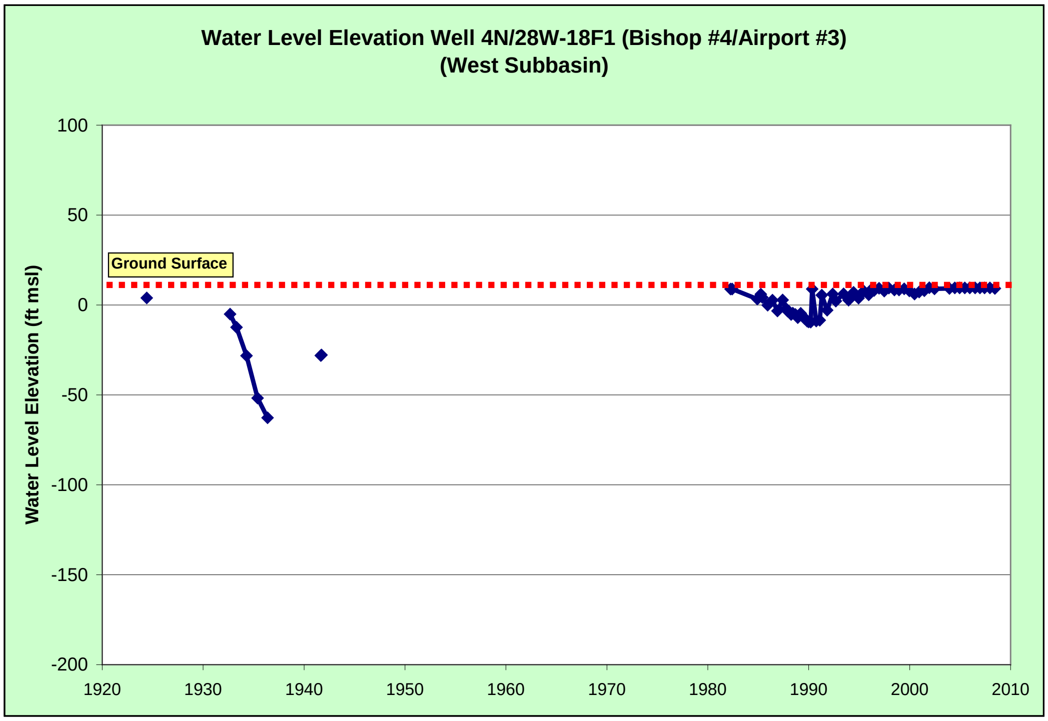


Figure 2-12. Hydrograph of well 18F1 in West subbasin.

3 Groundwater Quality and Pumping

3.1 Groundwater Quality

Groundwater quality considerations in basin management generally involve several aspects of water quality: 1) existing poor-quality water in parts of the basin that must be prevented from spreading across the basin (e.g., areas of saline water or high nitrates), 2) potential degradation of basin water by poor-quality water being pulled in from areas outside the aquifers (e.g., intrusion of seawater or high salts being pulled from surrounding sediments), and 3) overlying sources of contamination that could leak into the aquifers (e.g., leaking underground tanks). The Goleta Groundwater Basin has aspects of all three of these considerations.

Groundwater in the Goleta Groundwater Basin is of a calcium bicarbonate nature (DWR, 2009). Water quality is similar in nature to other coastal groundwater basins, where groundwater commonly flows through geologically-young marine sediments and becomes relatively mineralized. Chloride is an issue in some of the coastal basins, especially when there is a connection with the ocean and seawater intrusion can occur.

3.1.1 Historical Groundwater Quality

In early reports, water quality was considered fair in the Central subbasin, although chloride concentrations were somewhat elevated in portions of the West and North subbasins (up to about 200 mg/L) (Upson, 1951). Although below the drinking water standard, irrigation water with chloride at that concentration can harm salt-sensitive crops.

During the historical period 1980 to 2000 for which there are significant data on groundwater quality, chloride concentrations in the Central subbasin were generally less than the approximate 150 mg/L level that could affect salt-sensitive crops and well below the drinking water standard of 500 mg/L (Figure 3-1). However, portions of the North and West subbasins had chloride concentrations above the drinking water standard. Historical nitrate levels were significantly below the drinking water standard except in three wells (Figure 3-2); this is surprising, given the rural agricultural heritage of the basin (agricultural fertilizers, concentrations of ranch animals, and septic systems are the largest sources of nitrate in many basins). Both sulfate and total dissolved solids (TDS) were above the secondary drinking water standards in many wells in the North and West subbasins (Figure 3-3, Figure 3-4).

Iron and manganese have historically been a problem in the basin, with most wells in all subbasins having a maximum recorded concentration above the secondary drinking water standards (Figure 3-5, Figure 3-6).

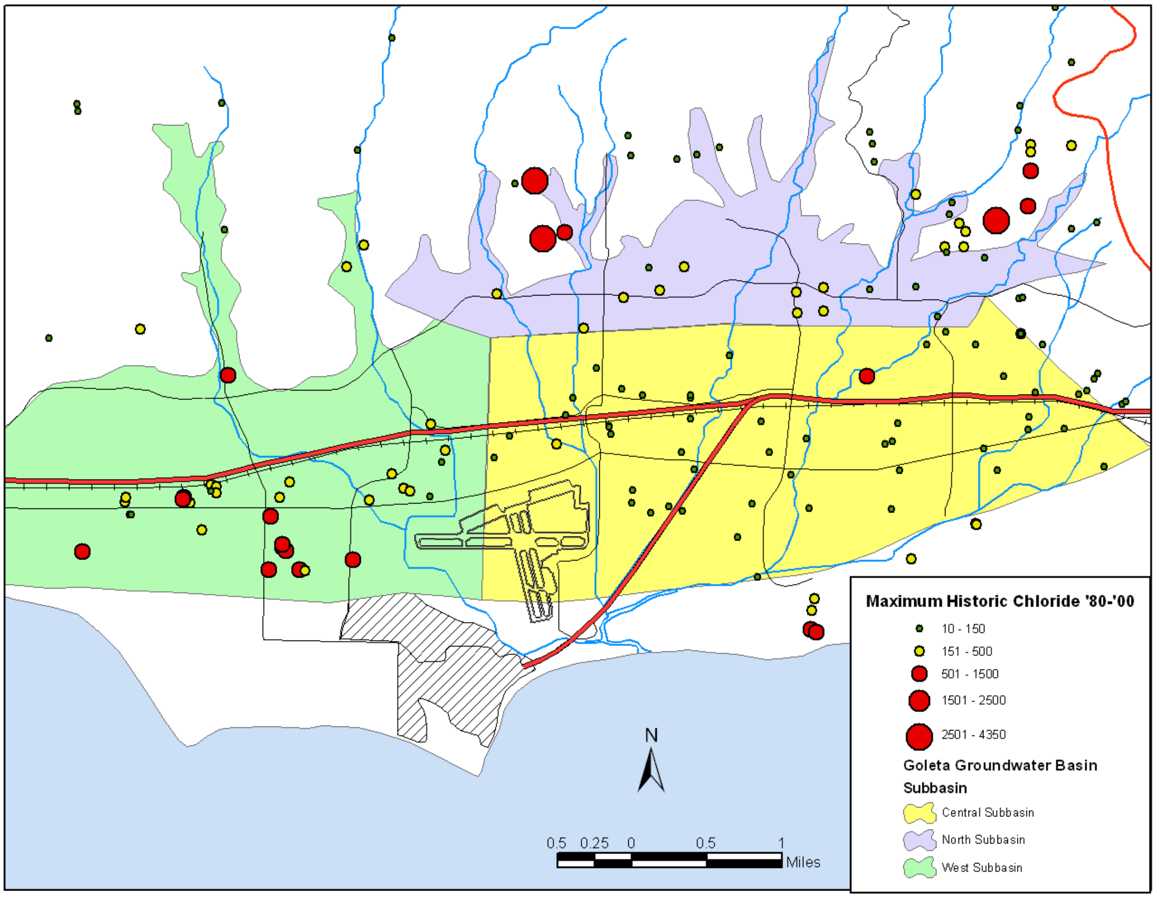


Figure 3-1. Maximum historic chloride concentrations in wells from 1980 to 2000. Concentrations are in mg/L. 500 mg/L is the secondary drinking water standard for chloride; crop damage may occur in salt-sensitive crops when irrigation water is above about 150 mg/L.

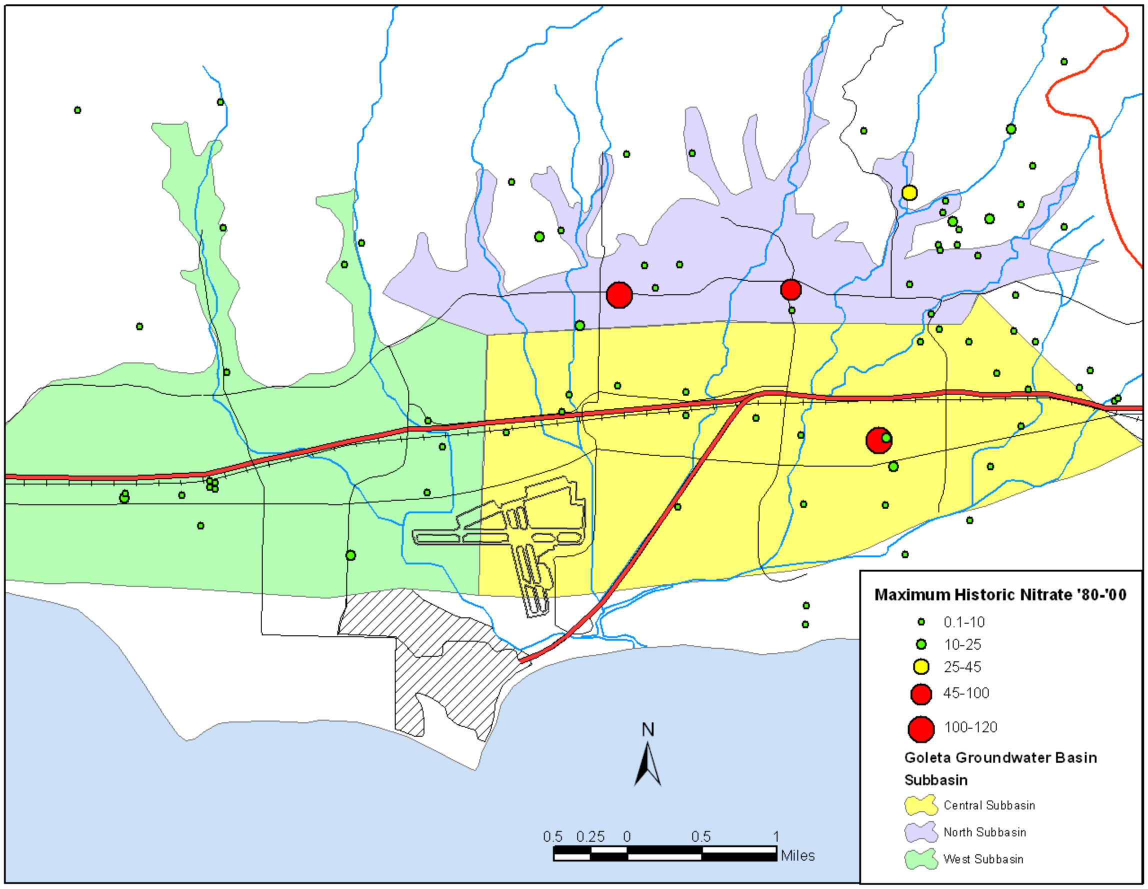


Figure 3-2. Maximum historic nitrate concentrations in wells from 1980 to 2000. Concentrations are in mg/L of NO_3. 45 mg/L of nitrate as NO_3 is a primary drinking water standard.

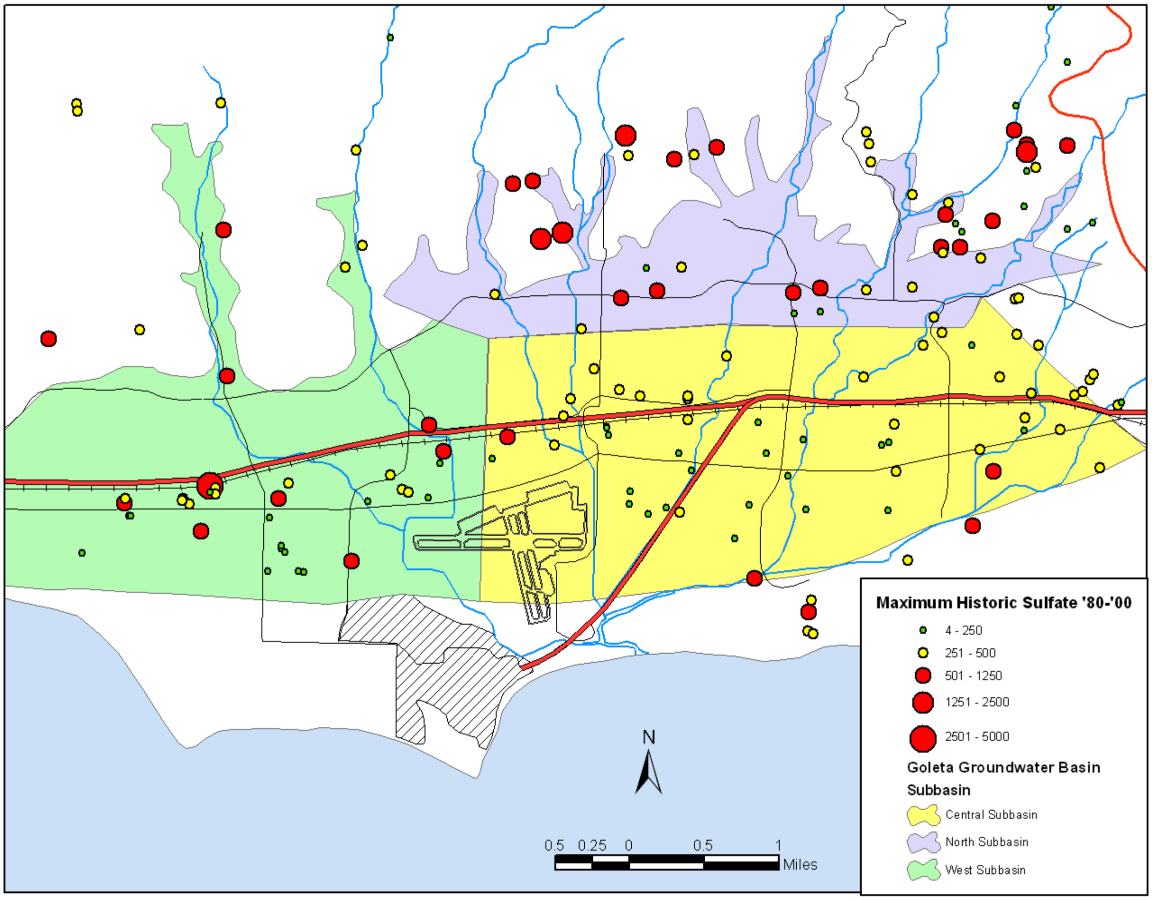


Figure 3-3. Maximum historic sulfate concentrations in wells from 1980 to 2000. Concentrations are in mg/L. 500 mg/L is the secondary drinking water standard for sulfate.

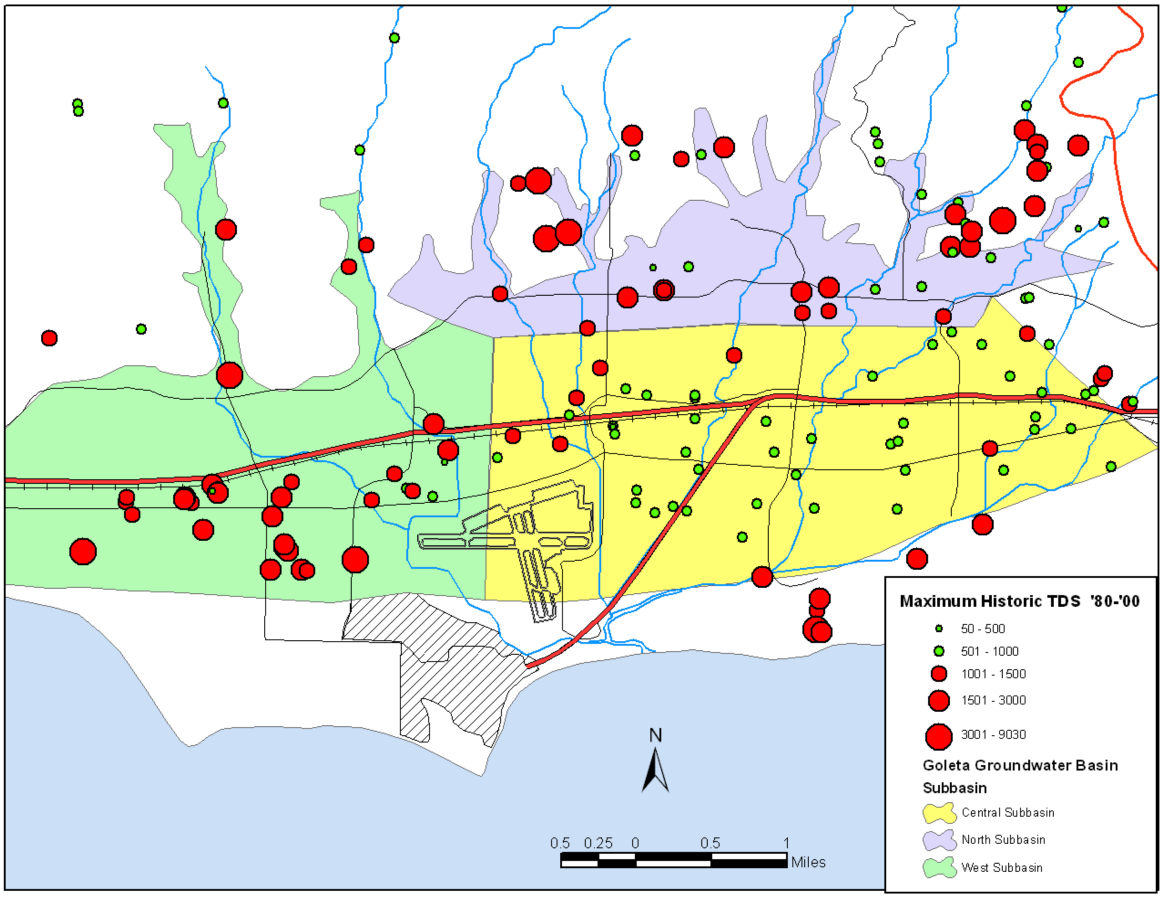


Figure 3-4. Maximum historic total dissolved solids (TDS) concentrations in wells from 1980 to 2000. Concentrations are in mg/L. 1000 mg/L is the secondary drinking water standard for TDS.

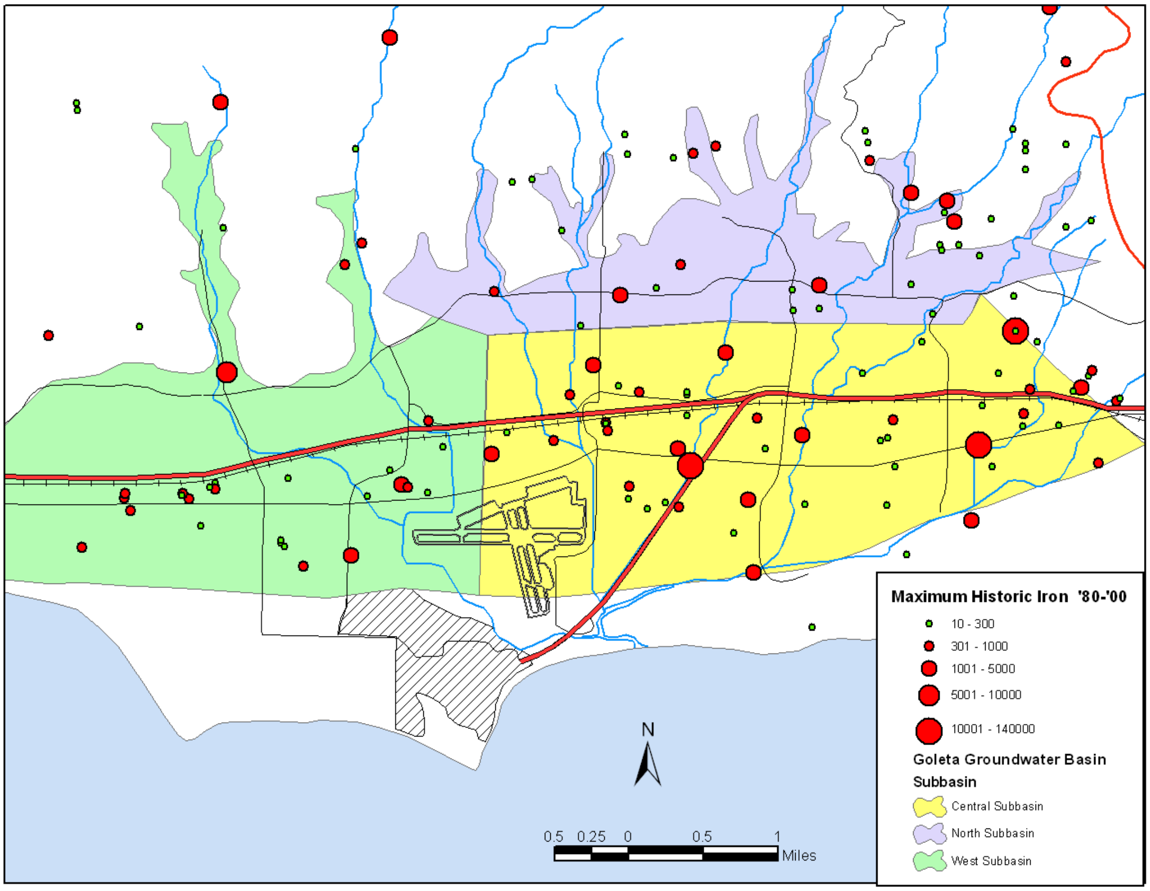


Figure 3-5. Maximum historic iron concentrations in wells from 1980 to 2000. Concentrations are in µg/L. 300 µg/L is the secondary drinking water standard for iron.

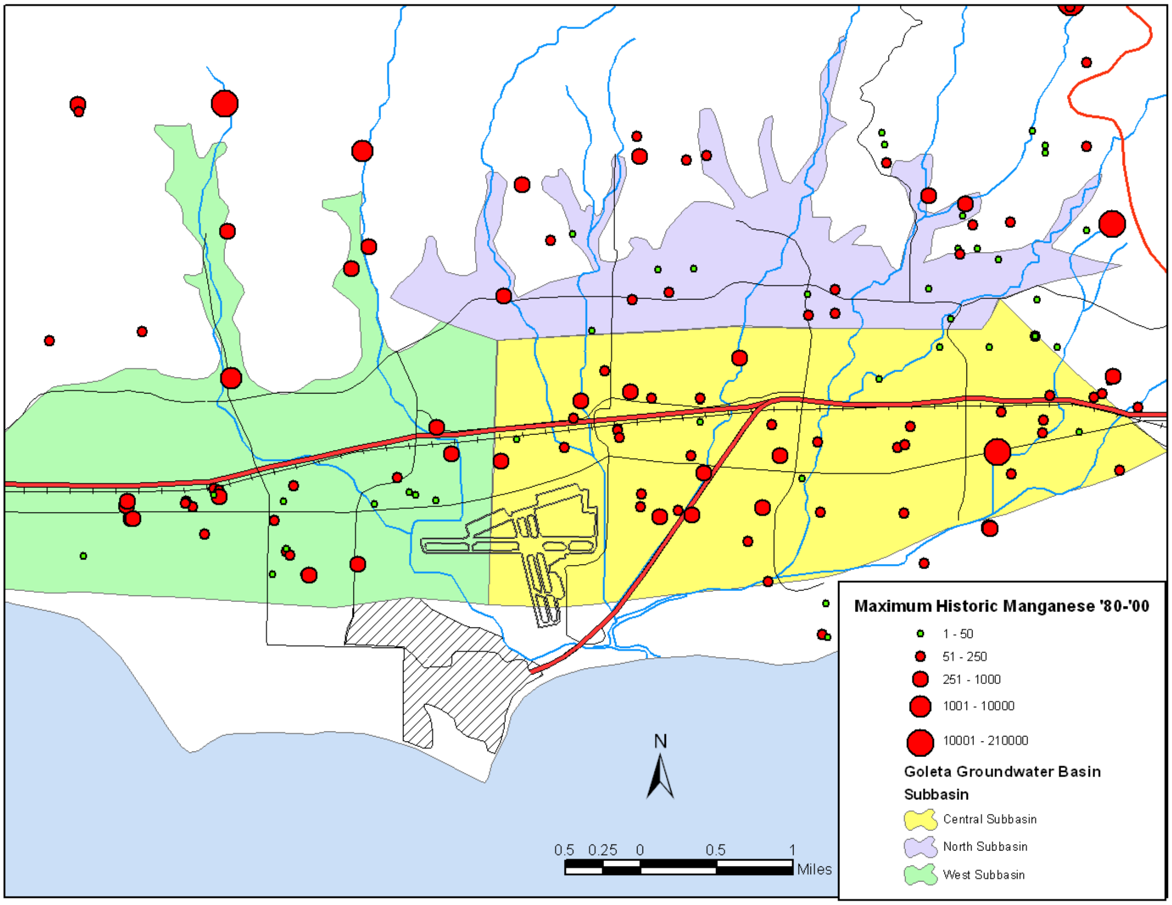


Figure 3-6. Maximum historic manganese concentrations in wells from 1980 to 2000. Concentrations are in µg/L. 50 µg/L is the secondary drinking water standard for manganese.

3.1.2 Current Groundwater Quality

A series of maps of concentrations of key chemicals are included as Figure 3-7 to Figure 3-12. None of the reporting wells had chloride concentrations above the drinking water standard during the last decade (Figure 3-7). However, the chloride concentration in an industrial well in the southern portion of the Central subbasin was 370 mg/L in 2007. The well was above the secondary (taste and odor) drinking water standard (Maximum Contaminant Level or "MCL") for Total Dissolved Solids (TDS). Iron and manganese continue to be a problem that can require treatment of drinking water before it is served to customers – most of the groundwater in the Central subbasin has concentrations of these two constituents that are above the secondary drinking water standard (Figure 3-11 and Figure 3-12).

Trends in water quality over the last two decades are illustrated in Figure 3-13 to Figure 3-19. Chloride concentrations in the Central subbasin generally reached their maximum in the late 1980s and early 1990s, decreasing after that time (Figure 3-14). This period of poorer groundwater quality coincides with the period of heaviest pumping from the basin (Figure 3-21), a correlation that needs to be considered in basin management schemes. Injection of lower-chloride Cachuma spill water may also have contributed to better-quality groundwater near La Cumbre's wells.

There are a number of spills and leaks of contaminants at the ground surface overlying the Goleta Groundwater Basin (Figure 3-20). The spilled or leaked contaminants range from gasoline (the most common) to dry cleaning fluid. The agency responsible for enforcing the cleanup of most of these sites is the State Water Resources Control Board, through the local Regional Water Quality Control Board. The Regional Board tracks each of these sites, approves remediation plans, and eventually determines when the site is remediated and the case is closed. For the roughly 175 sites in this Goleta-Santa Barbara area, their current status is:

- 50% have been remediated and the case is closed;
- 20% are currently being remediated;
- 25% are currently being assessed for possible remediation; and
- 5% are currently being monitored for verification of contamination.

These spills and leaks are only a potential problem to the aquifers in areas of the basin where there are no confining layers that separate the aquifers from the surface soils – the danger is in the recharge areas to the basin where contaminants may move freely from the ground surface to the aquifer. These recharge areas, which are discussed in the earlier section 2.3-*Sources of Recharge*, are generally in the foothills to the north of the majority of the spills. Periodically reviewing the status of contamination sites near public water supply wells is a recommendation discussed in section 5-*Recommended Future Strategies*.

The interface between overall groundwater management and remediation of contaminated sites occurs when regional groundwater gradients affect remediation of a site. This may especially be true in the West subbasin, where very high groundwater elevations and lack of significant water-supply pumping may hamper site remediation efforts.

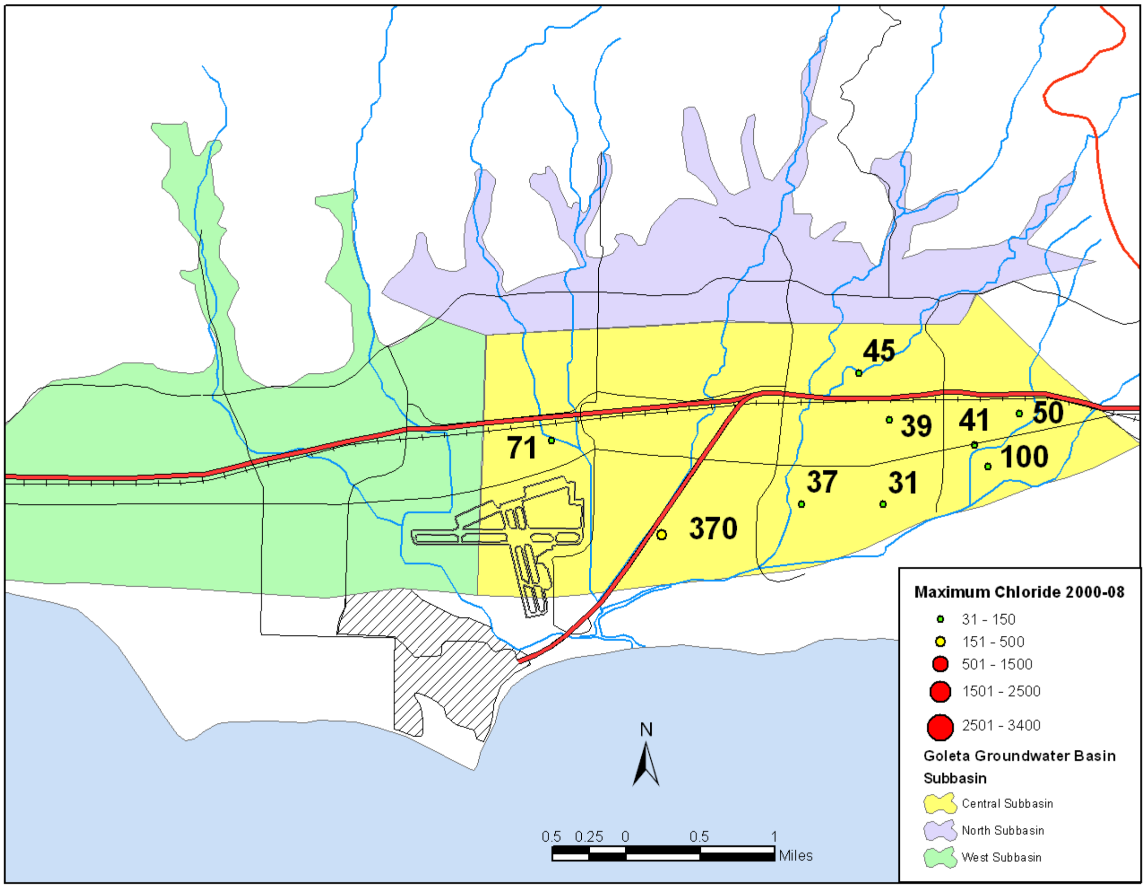


Figure 3-7. Maximum chloride concentrations reported to DPH from wells during the 2000s. Concentrations are in mg/L. 500 mg/L is the secondary drinking water standard for chloride.

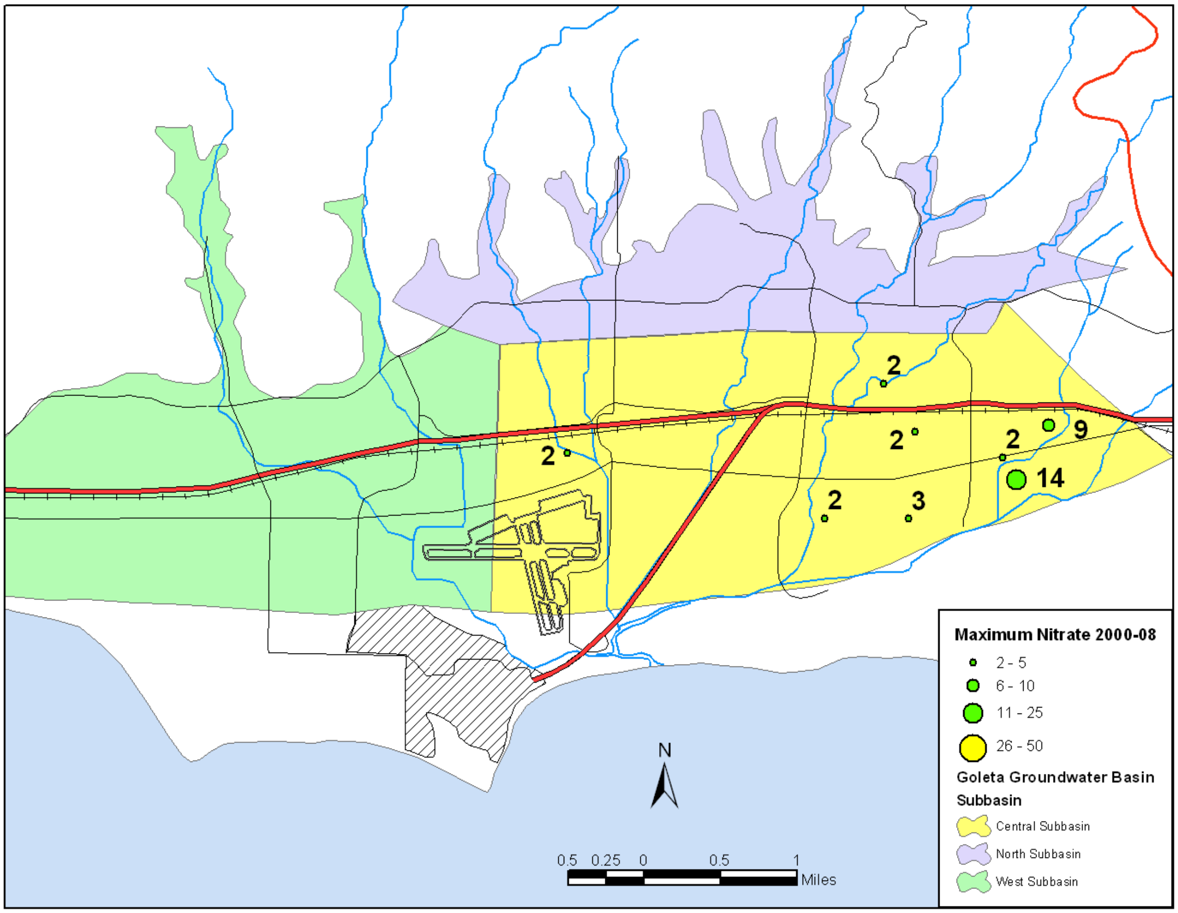


Figure 3-8. Maximum nitrate concentrations reported to DPH from wells during the 2000s. Concentrations are in mg/L of NO_3. 45 mg/L of nitrate as NO_3 is a primary drinking water standard.

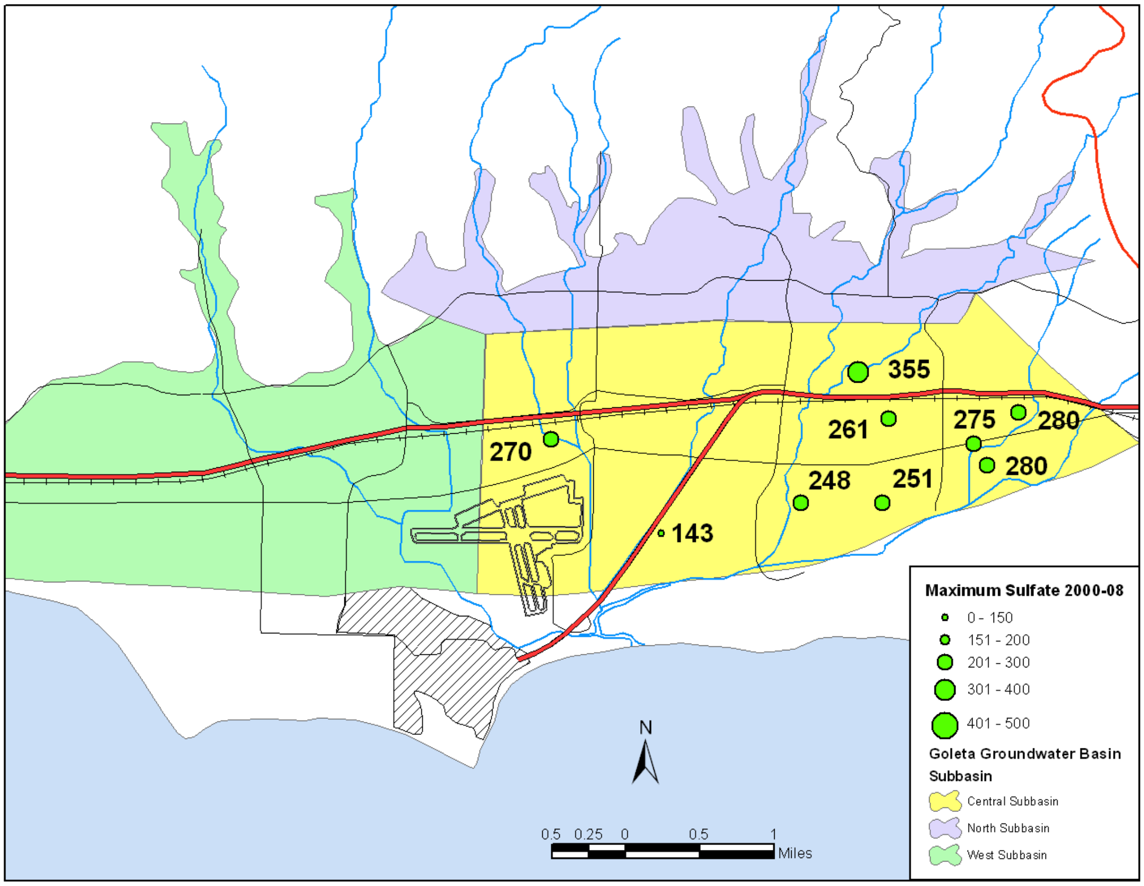


Figure 3-9. Maximum sulfate concentrations reported to DPH from wells during the 2000s. Concentrations are in mg/L. 500 mg/L is the secondary drinking water standard for sulfate.

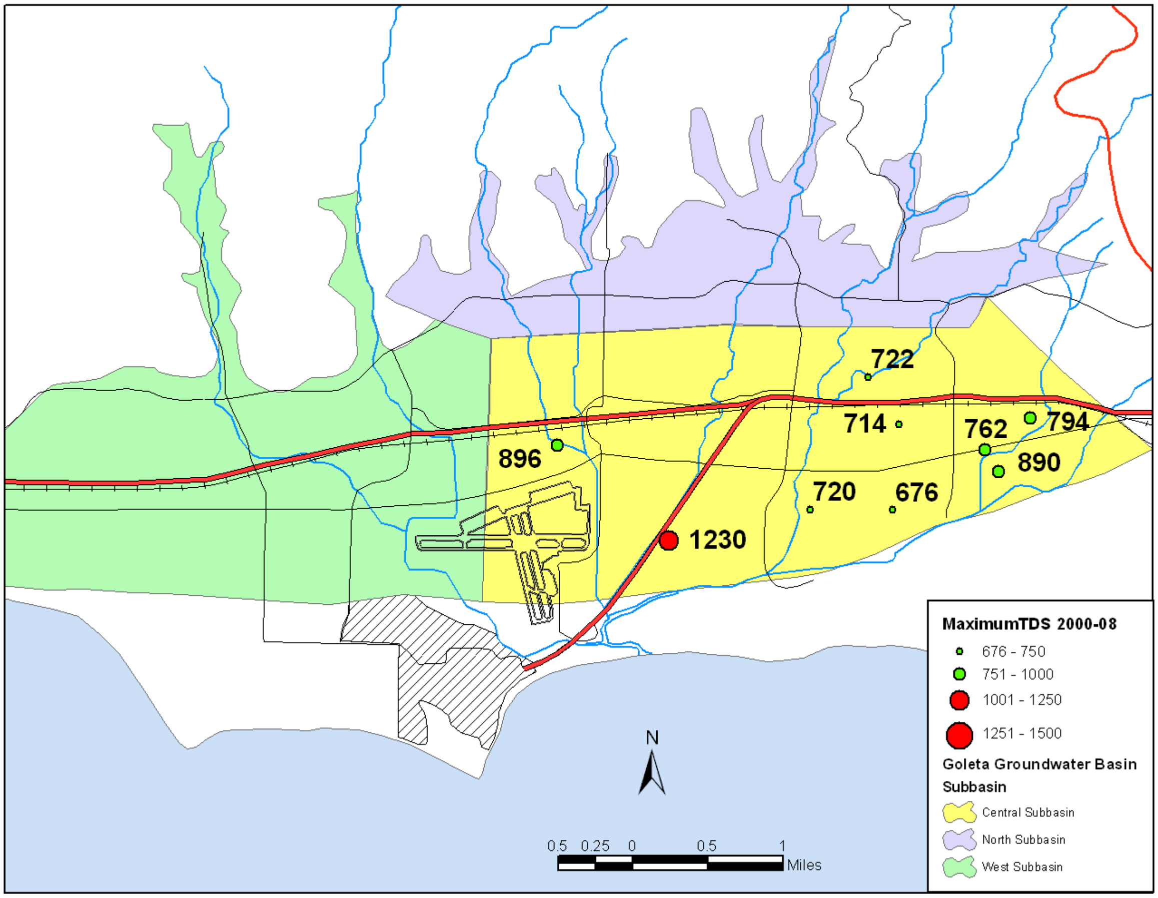


Figure 3-10. Maximum total dissolved solids (TDS) concentrations reported to DPH from wells during the 2000s. Concentrations are in mg/L. 1000 mg/L is the secondary drinking water standard for TDS.

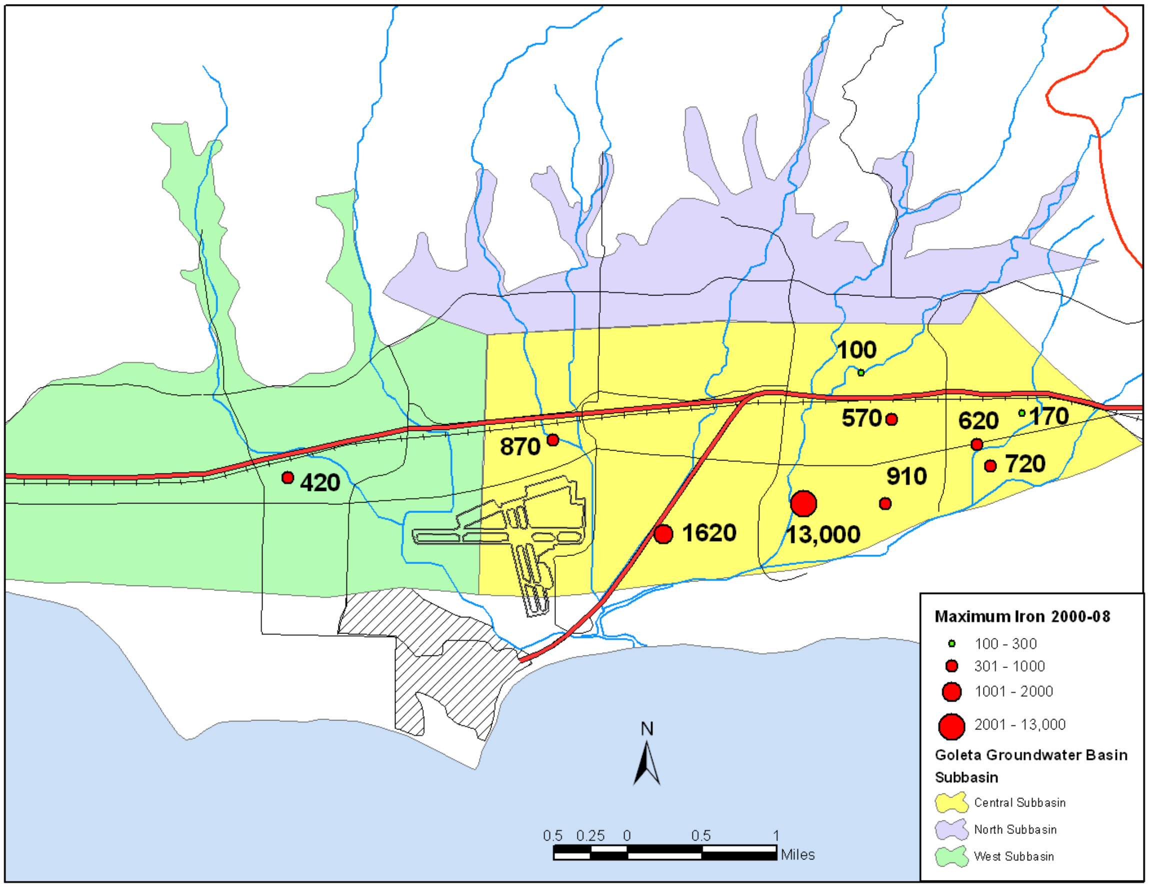


Figure 3-11. Maximum iron concentrations reported to DPH from wells during the 2000s. Concentrations are in µg/L. 300 µg/L is the secondary drinking water standard for iron.

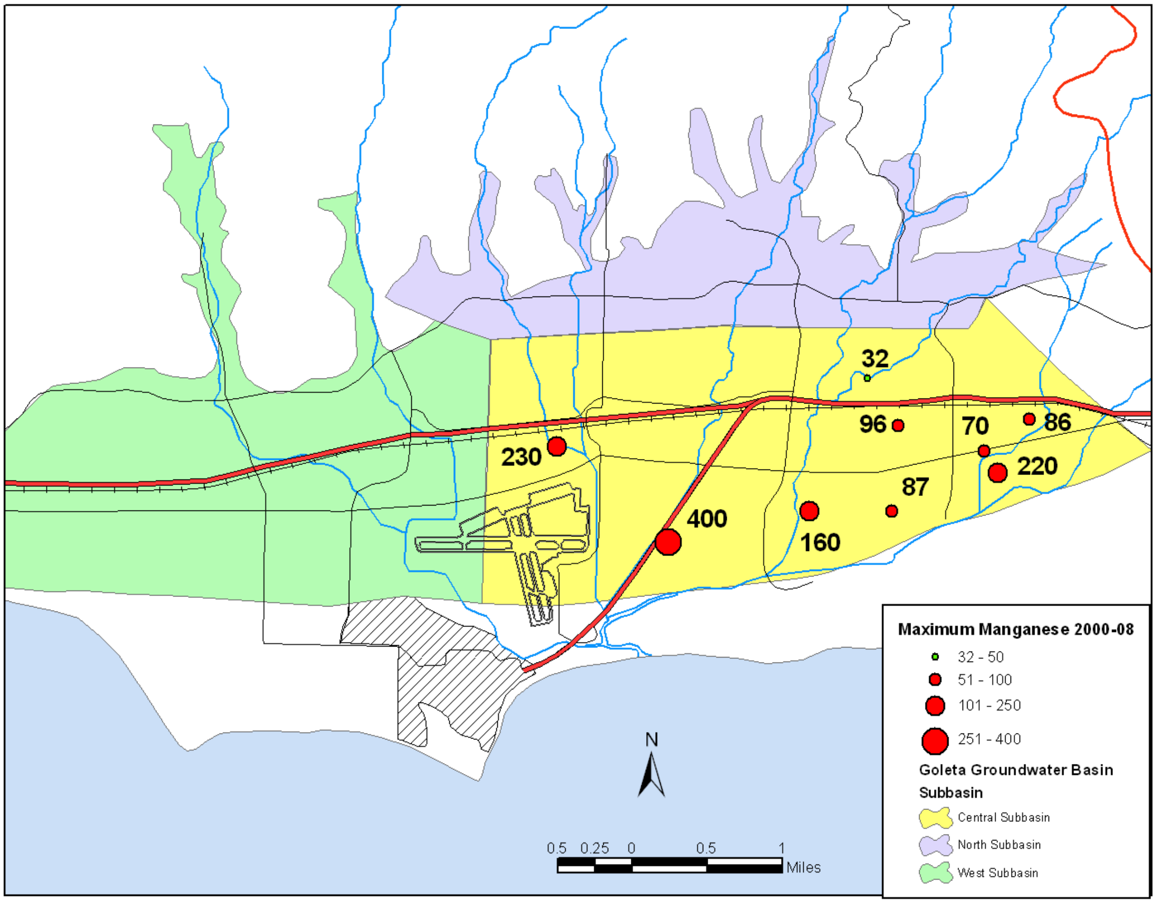


Figure 3-12. Maximum manganese concentrations reported to DPH from wells during the 2000s. Concentrations are in µg/L. 50 µg/L is the secondary drinking water standard for manganese.

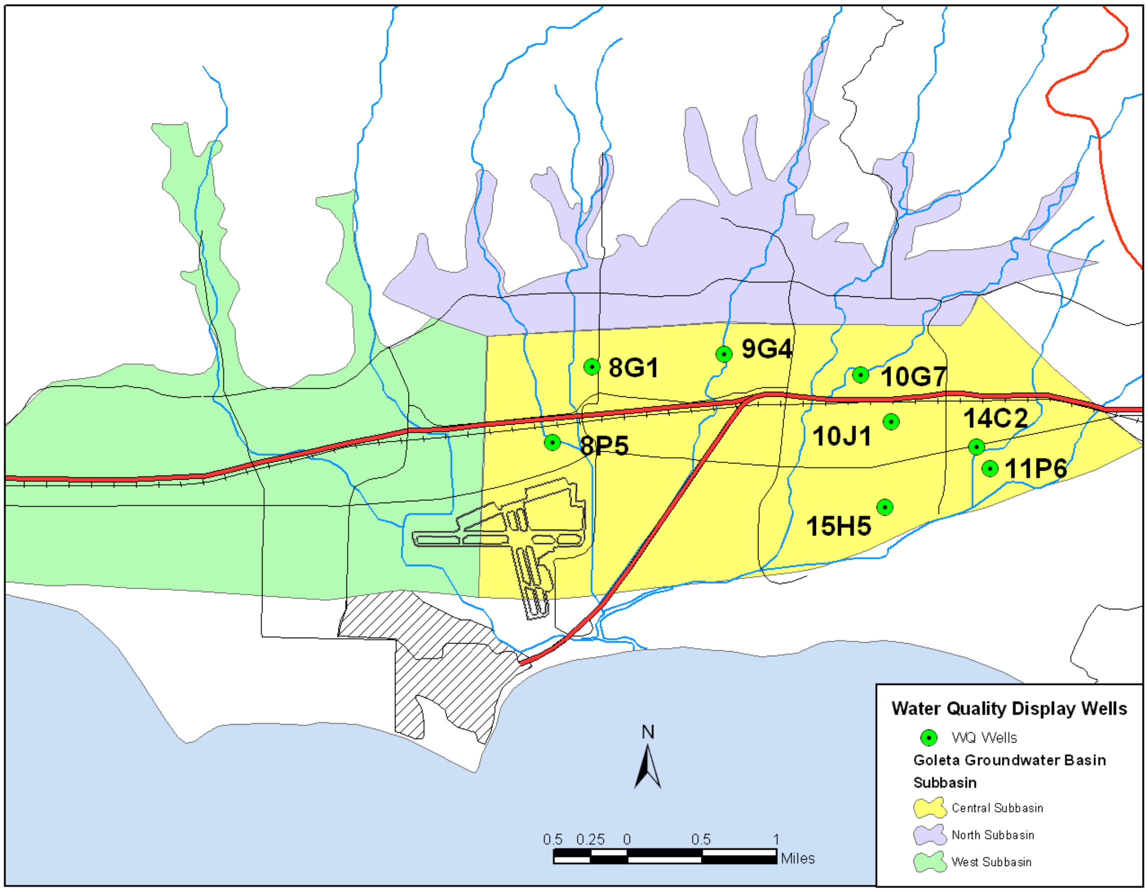


Figure 3-13. Location of wells used in water quality charts.

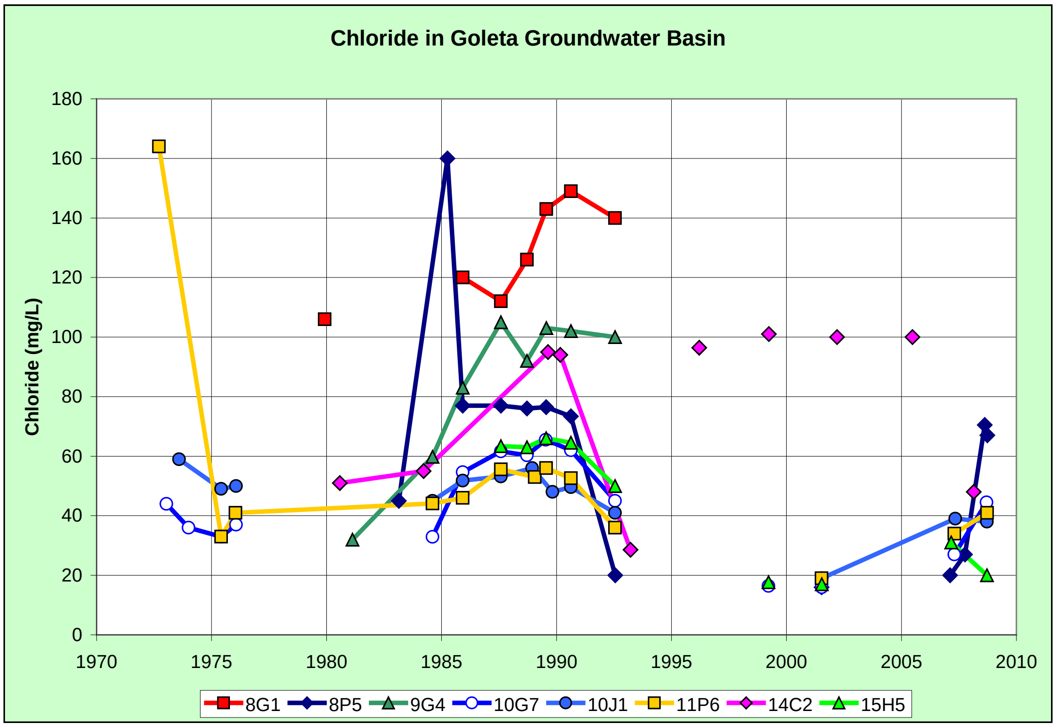


Figure 3-14. Chloride in selected wells in Goleta Groundwater Basin. 500 mg/L chloride is a secondary drinking water standard. Agricultural suitability is the primary factor in setting the BMO at 150 mg/L (see section 4.1-*Basin Management Objectives*). Wells located on Figure 3-13. Names of wells: 8G1=GWD "Sherrill", 8P5=GWD "Airport", 9G4=GWD "Berkeley #2", 10G7=GWD "University", 10J1=GWD "El Camino", 11P6=GWD "San Marcos", 14C2=La Cumbre MWC #17, 15H5=GWD "Anita #2".

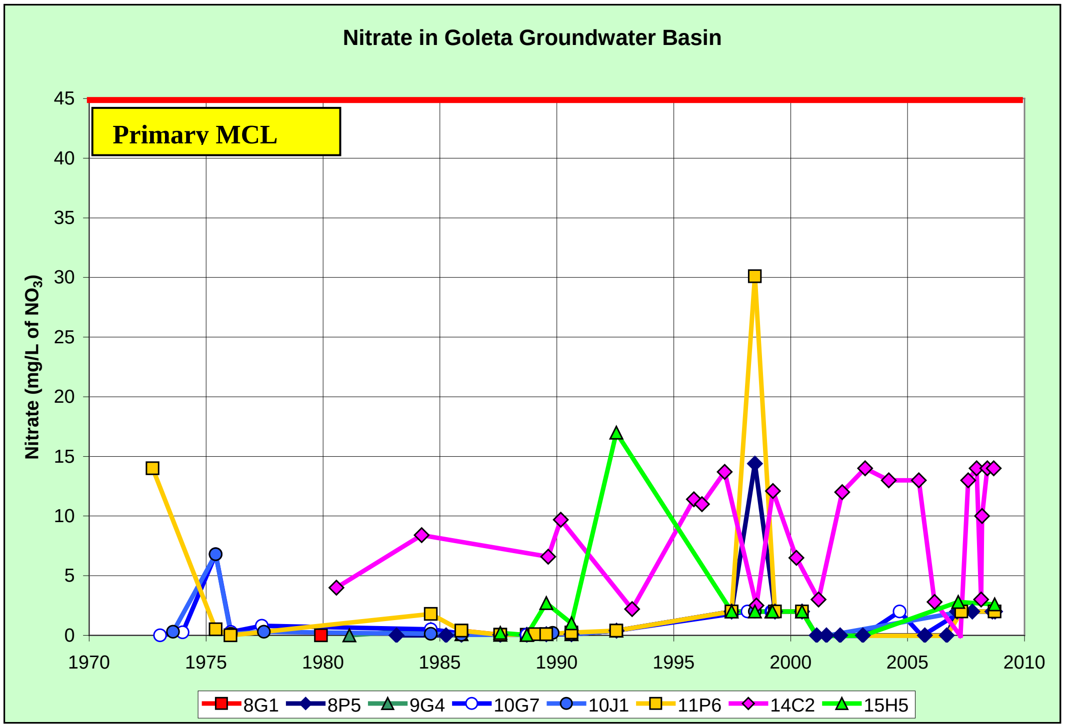


Figure 3-15. **Nitrate (as NO_3) in selected wells in Goleta Groundwater Basin. 45 mg/L of nitrate as NO_3 is a primary drinking water standard. Wells located on Figure 3-13. See Figure 3-14 caption for well names.**

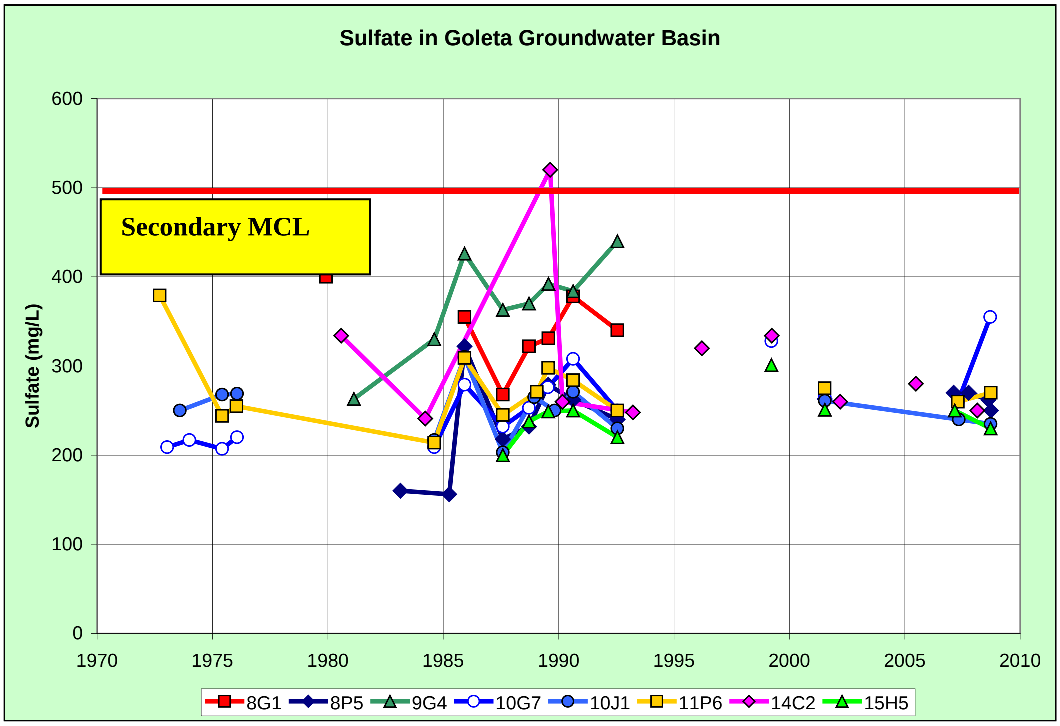


Figure 3-16. **Sulfate in selected wells in Goleta Groundwater Basin. 500 mg/L is the secondary drinking water standard for sulfate. Wells located on Figure 3-13. See Figure 3-14 caption for well names.**

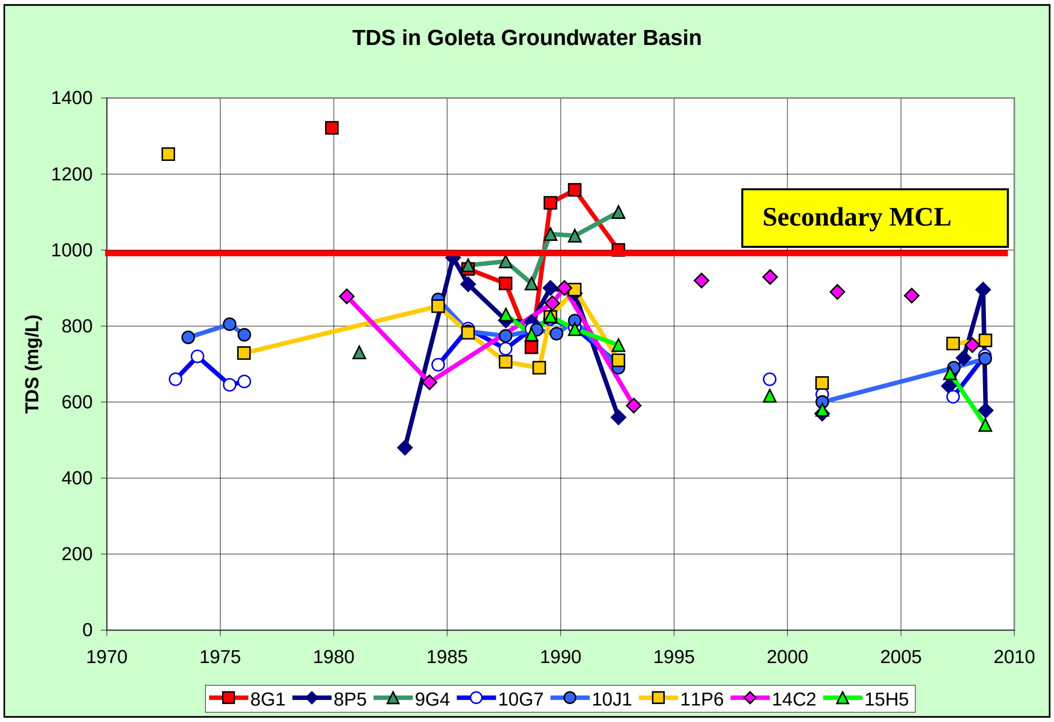


Figure 3-17. Total Dissolved Solids (TDS) in selected wells in Goleta Groundwater Basin. 1000 mg/L is the secondary drinking water standard for TDS. Wells located on Figure 3-13. See Figure 3-14 caption for well names.

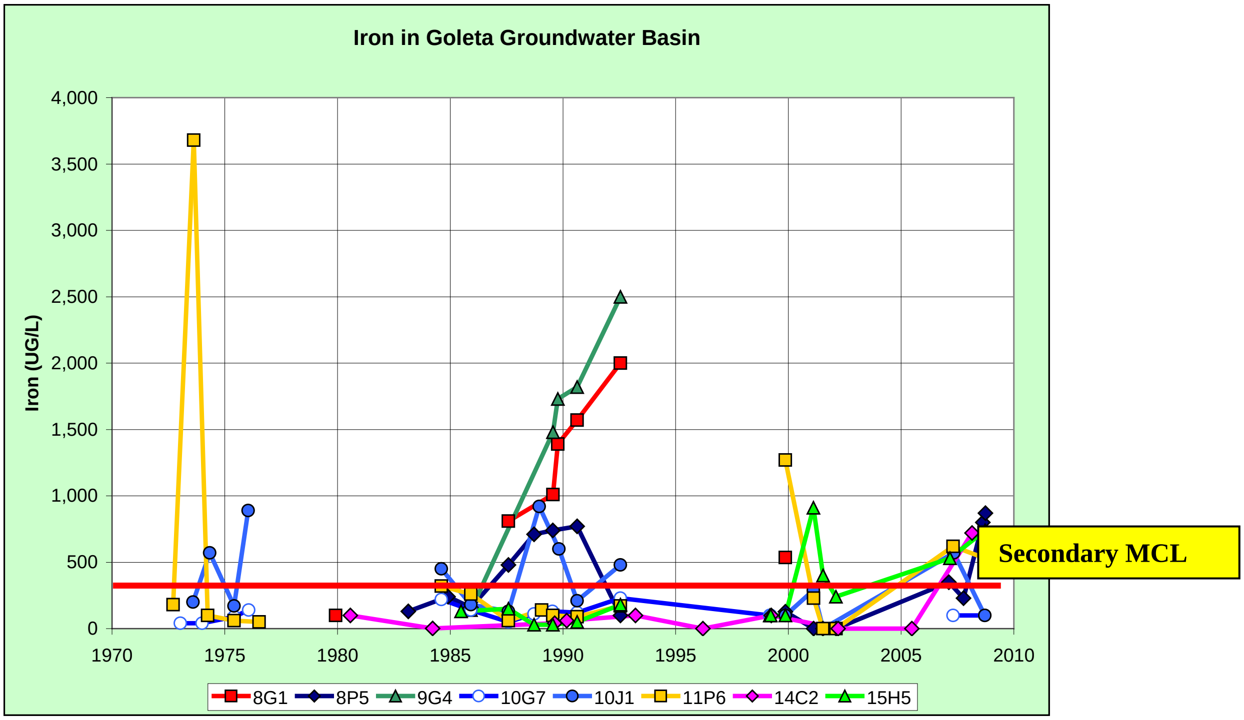


Figure 3-18. Iron in selected wells in Goleta Groundwater Basin. 300 µg/L is the secondary drinking water standard for iron. Wells located on Figure 3-13. See Figure 3-14 caption for well names.

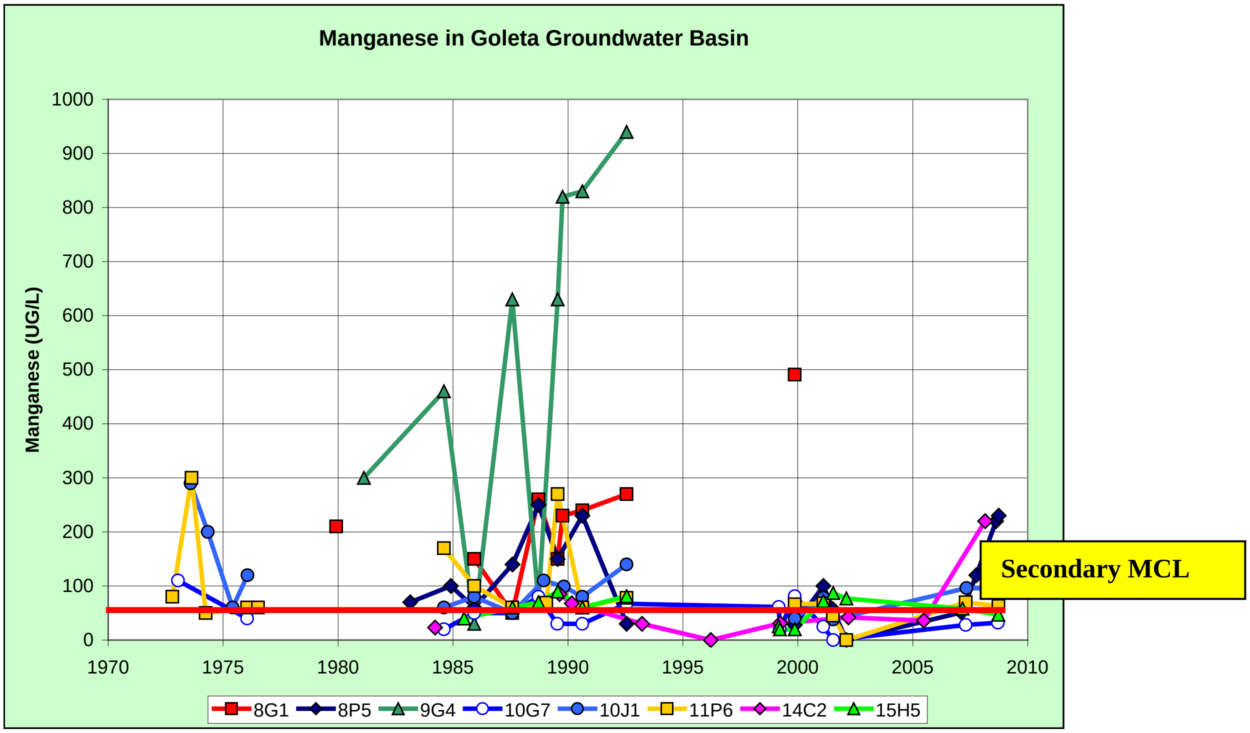
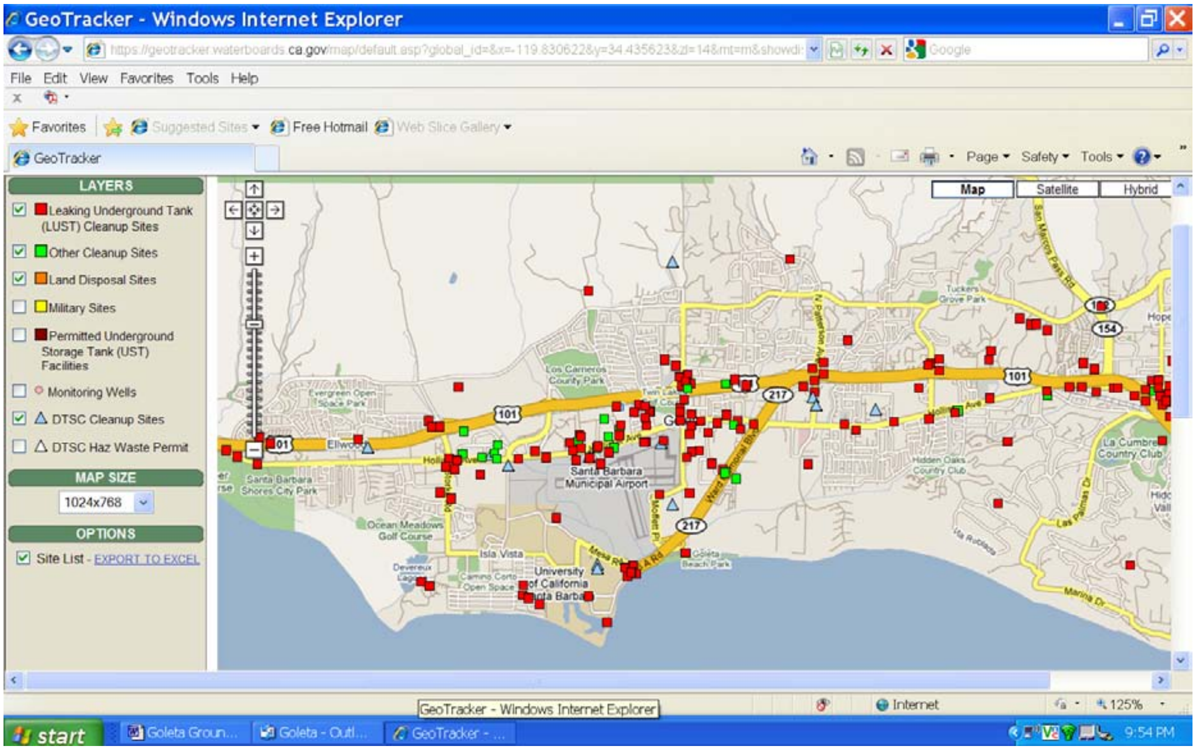


Figure 3-19. Manganese in selected wells in Goleta Groundwater Basin. 50 µg/L is the secondary drinking water standard for manganese. Wells located on Figure 3-13. See Figure 3-14 caption for well names.



☑ Leaking Underground Tank (LUST) Cleanup Sites
☑ Other Cleanup Sites
☑ Land Disposal Sites
☐ Military Sites
☐ Permitted Underground Storage Tank (UST) Facilities
☐ Monitoring Wells
☑ DTSC Cleanup Sites
☐ DTSC Haz Waste Permit

MAP SIZE: 1024x768

☑ Site List - EXPORT TO EXCEL

Figure 3-20. Location of surface contamination sites in the Goleta Groundwater Basin, from GeoTracker program of the State Water Resources Control Board. Many of the sites are no longer active – they have been remediated and the case closed.

3.2 Groundwater Pumping and Injection

The first wells were drilled in the Goleta Groundwater Basin in about 1890 (Upson, 1951). They were shallow artesian flowing wells, generally less than 100 ft deep. During the early history of groundwater use, there was sufficient piezometric pressure to raise water from a well as much as 30 ft above ground surface (Upson, 1951), but that diminished with time as more wells were drilled and aquifer pressures dropped. Deeper, larger-diameter wells were then drilled, pumps were installed, and groundwater was used to develop fruit and nut orchards. By the late 1930s, various reports estimated groundwater use to be somewhere between 3,000 and 6,000 acre-feet per year, with Upson (1951) reporting average pumping of 4,600 acre-feet per year during the 1930s and 1940s.

As urbanization replaced agriculture, public water producers became a larger factor in the use of groundwater in the Goleta Groundwater Basin. La Cumbre formed in 1925 to serve the developing Hope Ranch area. For close to forty years, groundwater pumping was the sole source of La Cumbre's water supply. GWD first began producing groundwater in 1963, with less than 1,000 acre-feet per year produced before 1970 (GWD, 2008). More-complete records of groundwater extractions began around 1970, with pumping by GWD, La Cumbre MWC, and private parties indicated on Figure 3-21. Overall pumping in the basin peaked in the latter half of the 1980s in the range of 6,000 to 8,000 acre-feet per year. Starting in the 1990s, basin pumping declined dramatically, largely as the result of the Wright Judgment, the SAFE Ordinance, and the end of the drought.

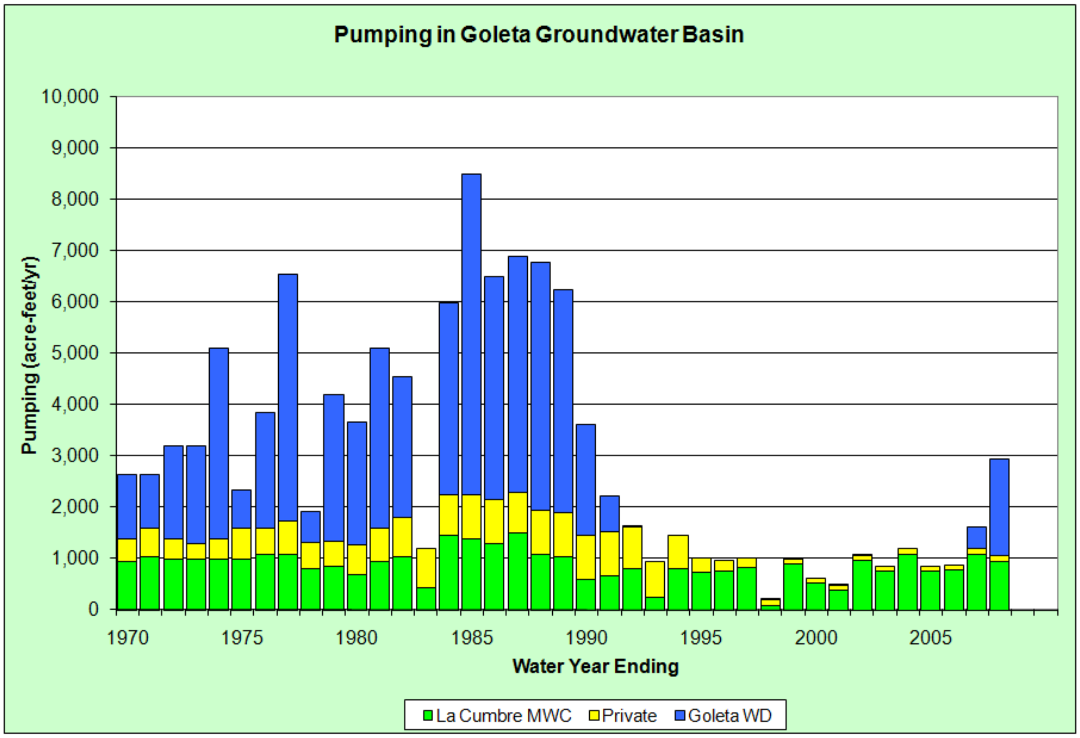


Figure 3-21. Historical pumping in the Goleta Groundwater Basin.

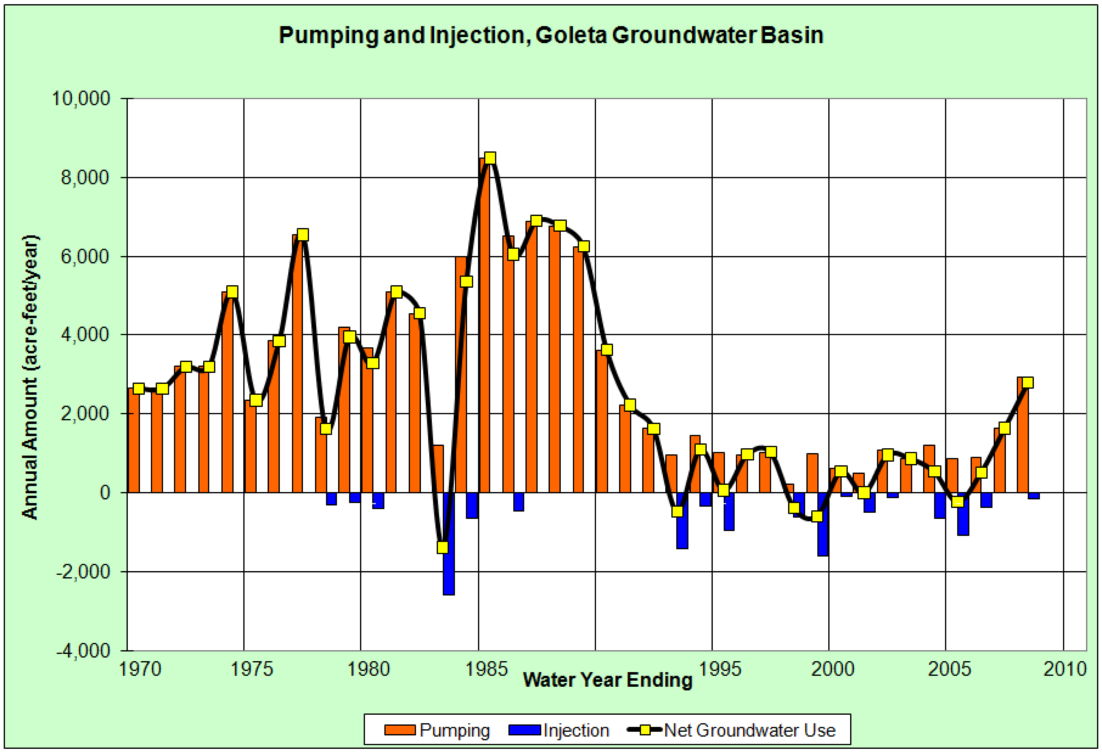


Figure 3-22. Historical pumping and injection in the Goleta Groundwater Basin.

3.3 Operation of ASR Project

The Goleta Groundwater Basin was one of the first basins to enhance natural recharge by injecting drinking water into wells. The early injection by GWD was simple – place a fire hose in the well, connect it to a hydrant, and fill the well to near its top, allowing gravity to push the water into the aquifer through the same perforations in the well casing from which water was produced from the aquifer. This injection was initiated in the late 1970s and has been used whenever there are excess surface supplies available in wetter years (Figure 3-22). Over 1,500 acre-feet of water have been injected in a single year in the basin (see section 4.4.1-*Groundwater Storage Programs*).

The source of water injected by GWD is spill water from Lake Cachuma. The GWD's recent rehabilitation of its well facilities included a special retrofit of its wells for use as dual-purpose injection-extraction wells (commonly referred to as "Aquifer Storage and Recovery," or "ASR" wells) to maximize injection capacity. These actions were undertaken to maximize conjunctive use potential of the basin and Cachuma Reservoir.

Water that is injected becomes available to be used in dry years when surface water supplies are reduced. In this way the surface and groundwater supplies are used "conjunctively". Conjunctive use operations allow a more efficient use of both surface and groundwater supplies. Over the last 16 years, the GWD has injected 7,129 acre-feet, or 446 acre-feet per year on an average annual basis.

4 Basin Management

4.1 Basin Management Objectives

Basin Management Objectives ("BMOs") are quantitative targets established in a groundwater basin to measure and evaluate the health of the basin. BMOs can be groundwater elevations and/or chemical concentrations in wells. For the Goleta Groundwater Basin, the water level BMOs are set at the lowest measured historical static (non-pumping) groundwater elevation in each BMO well. If groundwater elevations in a BMO well fall below this elevation, the BMO will be considered to have not been met and the basin will be considered to be in distress. This criterion for the water level BMO is based on the observation that a groundwater elevation that low in the well in the past did not harm the basin, but a groundwater elevation below the BMO may create potential undesirable effects.

An additional BMO in the basin is maintaining concentrations of nitrate and chloride at or below levels that are harmful to human health or damaging to irrigated crops. The BMO for nitrate is set at one-half of the drinking water primary standard of 45 mg/L nitrate as NO_3 (one-half the standard is the level at which increased monitoring and testing is required by the California Department of Health Services for drinking water). Concentrations of nitrate higher than the standard of 45 mg/L can potentially cause Blue-Baby syndrome. A chloride concentration of 150 mg/L or lower is generally protective of irrigated crops, although salt-sensitive crops such as avocado and strawberries may see the beginning of reductions in yield at concentrations slightly lower than that. The BMO wells (Figure 4-1) and criteria (Table 4-1) are listed below.

All of the BMO wells are currently being monitored for water levels twice a year as part of the USGS effort. Only a portion of the BMO wells are currently being regularly monitored for water quality. The addition of these wells to a water quality monitoring network is discussed in section 7.2 Appendix B *Additional Water Quality Monitoring*.

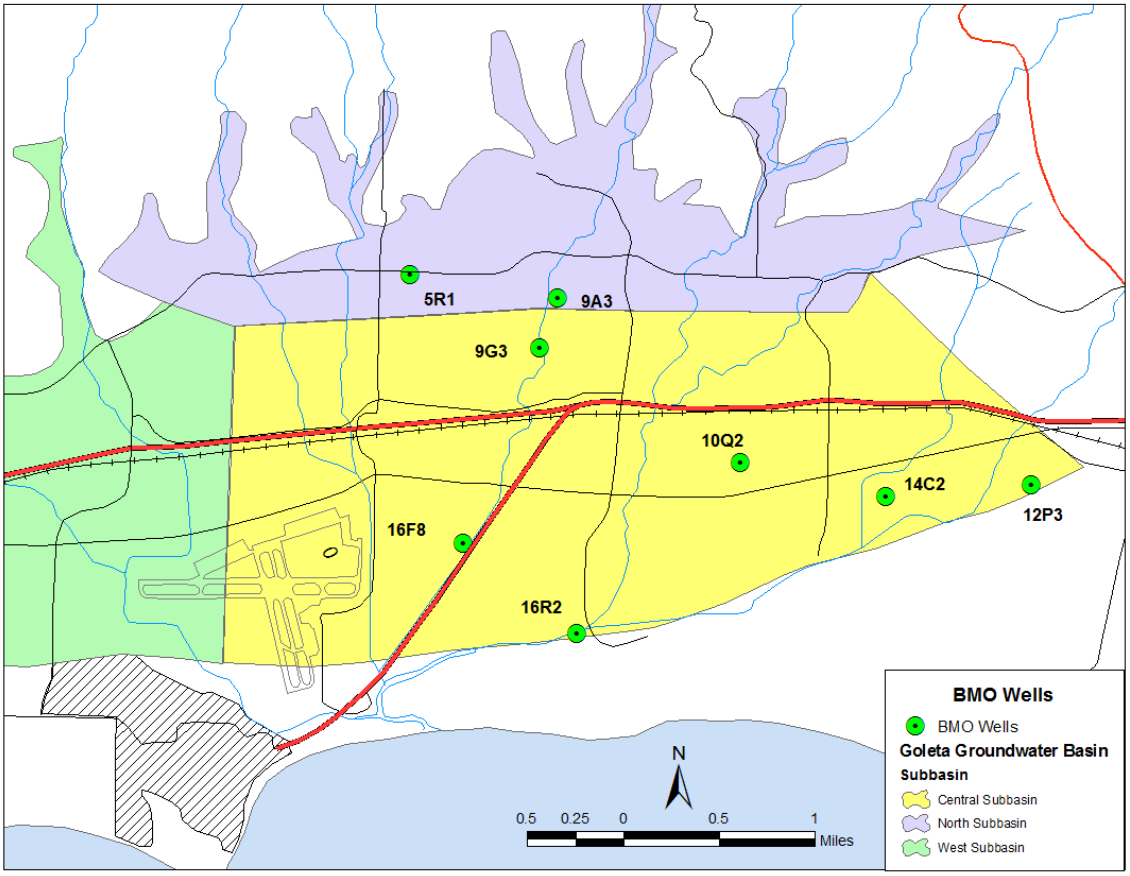


Figure 4-1. Locations of BMO wells.

Well	*Subbasin*	*WLE BMO*	*Nitrate BMO*	*Chloride BMO*	*Current WLE*	*Current Nitrate*	*Current Chloride*
4N/28W-5R1	North	15’	22.5	150	57’	NM	NM
4N/28W-9A3	North	15’	22.5	150	56’	NM	NM
4N/28W-9G3	Central	-75’	22.5	150	25’	0.4 (9G4)	100 (9G4)
4N/28W-10Q2	Central	-100’	22.5	150	-20’	NM	NM
4N/28W-12P3	Central	-180’	22.5	150	-27’	NM	NM
4N/28W-14C2	Central	-80’	22.5	150	-22’	14	48
4N/28W-16F8	Central	-58’	22.5	150	-10’	NM	NM
4N/28W-16R2	Central	-60’	22.5	150	14’	NM	NM

Table 4-1. BMOs for the Goleta Groundwater Basin. Chemical concentrations are in mg/L, nitrate is reported as NO_3. NM = no current measurements.

4.2 Basin Yield and Storage

The yield of a basin is the critical value in determining the amount of groundwater that can be pumped from a basin over the long term. This pumping is done within the storage capacity of the basin – if an excess of water is pumped from the storage of the basin, damage could occur to the aquifer, even if recharge eventually refills the basin.

4.2.1 Basin Yield

Although a basin yield has been proposed for a number of groundwater basins in California, calculating a yield is not an easy task. This can be demonstrated by the lack of technical agreement on basin yield in many of the basin adjudications in California where there are many experts looking at the problem and there are a range of calculations of basin yield. However, the yield of a basin can commonly be bracketed rather than precisely calculated. Basin yield can be expressed as “safe yield” (a term that can have a legal meaning), “perennial yield”, “basin yield”, or a like term. The term is generally defined as:

> The yield of a basin is the average quantity of water that can be extracted from an aquifer or groundwater basin over a period of time without causing undesirable results. Undesirable results include permanently lowered groundwater levels, subsidence, degradation of water quality in the aquifer, or decreased stream flow. If water management in the basin changes, the yield of the basin may change. The yield of a basin is the average amount of water that can be pumped annually over the long-term. Pumping in individual years may vary above or below this long-term yield during drought or wet years, or as part of basin management plans. (Bachman and others, 2005)

There have been several methods used to calculate the yield of the Goleta Groundwater Basin. Upson (1951) used what is commonly called the “Hill Method” (e.g., Bachman and others, 2005) where the amount of pumping each year is plotted against the change in groundwater elevations caused by that pumping. Theoretically, in a year when there is no net change in groundwater elevation, the amount of pumping in that year is the yield of the basin. Unfortunately, this method assumes that the recharge to the basin from year to year is relatively constant, making it problematic for use in California groundwater basins such as in Goleta. Using this method, Upson (1951) calculated a basin yield of about 2,000 acre-feet per year for the years 1936 to 1950 (he considered the confined areas of the Central subbasin). This period coincides with a long dry climatic cycle (see Figure 2-4) when recharge was below average. Thus, Upson’s number is very likely an underestimation of long-term basin yield.

The optimum situation for estimating basin yield would be if there happened to be a period when groundwater elevations remained unchanged during a period of average precipitation (and, thus, likely to be a period of average recharge). In such a situation, the average pumping over that period is likely to be an approximation of the yield of the basin. To investigate this possibility in the Goleta Groundwater Basin, Figure 4-2 was prepared to show the relationship between net pumping, climatic conditions, and groundwater elevation. The chart plots net pumping as columns, cumulative departure of rainfall (see Figure 2-4) as a line, and the groundwater elevation of well 4N/28W-9G3 as a line. Breaking the chart into distinct periods, several observations can be made:

- During the period 1970 to 1977, rainfall was near average (flat cumulative departure line) but groundwater elevations were dropping. This occurred when average net pumping was about 3,700 acre-feet per year. This suggests that basin yield is somewhat lower than 3,700 acre-feet per year.

- During the period 1978 to 1982, rainfall was above average but groundwater elevations continued to drop. This occurred when average net pumping was about 3,700 acre-feet per year. This suggests that basin yield is lower than 3,700 acre-feet per year.
- During the period 1984 to 1990, rainfall was below average and groundwater elevations continued to drop. This occurred when average net pumping was about 6,200 acre-feet per year. Nothing can be observed about basin yield.
- During the period 1992 to 2007, recharge and groundwater elevations both went up. This occurred during minimal net pumping. Nothing can be observed about basin yield.

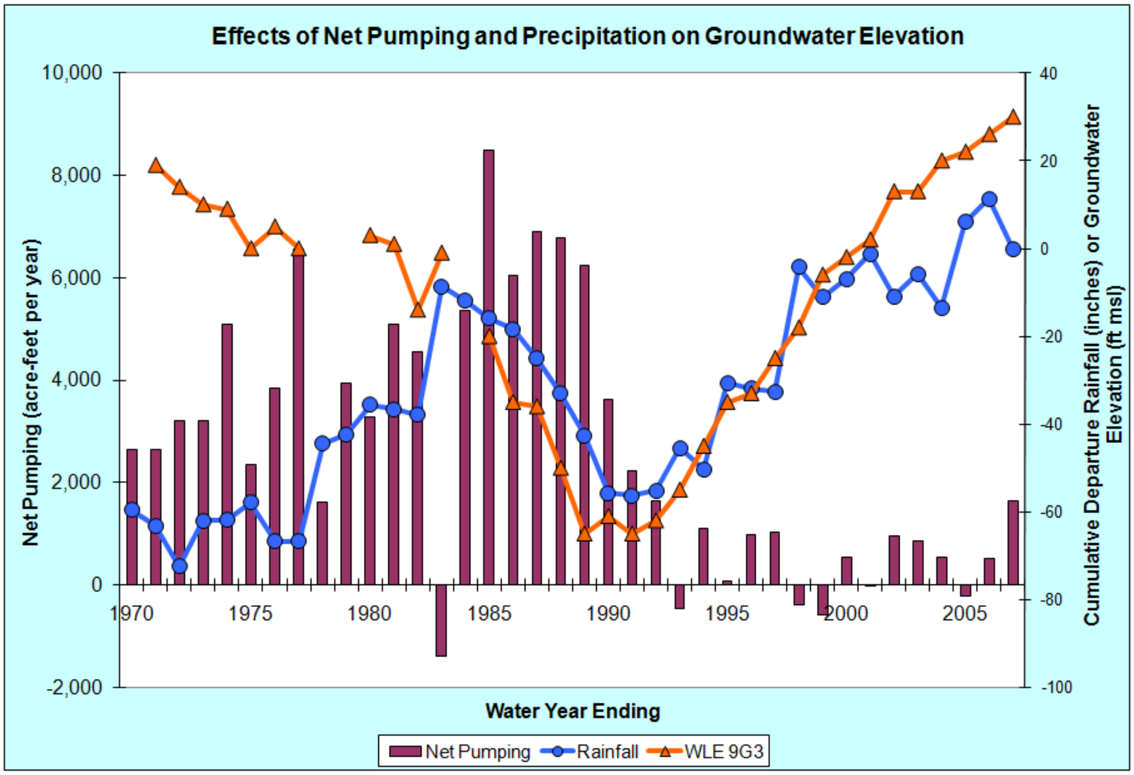


Figure 4-2. Effects of net pumping (pumping minus injection) and precipitation on groundwater elevation. Rainfall is plotted as cumulative departure of Goleta rainfall. Water level elevation is for the 9G3 well (GWD Berkeley #1) located in the northern portion of the Central subbasin. See text for interpretation.

Thus, the conclusion drawn from Figure 4-2 is that the yield of the basin is likely somewhat less than 3,700 acre-feet per year. In fact, the Wright Judgment established the safe yield of the basin as 3,410 acre-feet per year, with the perennial yield estimated as

3,700 acre-feet per year[7]. This safe yield number does not include any water stored in the basin by GWD or La Cumbre as a drought buffer.

4.2.2 Basin Storage

The amount of usable storage in a basin is important in determining how a basin should be operated through wet and dry climatic conditions. The yield of a basin is calculated such that no undesirable effects occur during pumping of the basin. Thus, usable storage in the basin should not be depleted during dry periods to the extent that these undesirable effects occur. An extreme example of this would be a basin with storage of only a few years of pumping, so that all the usable storage would be depleted during a long drought.

Basin storage is generally calculated by estimating how much water could be drained from pore space in the basin's aquifers, down to a certain elevation. Sometimes this lower elevation is set as deep as the top of poor quality water in the aquifers, which may be hundreds to thousands of feet below sea level. However, it is likely that there would be undesirable effects if groundwater was pumped down to that depth, so a storage number calculated in such a manner is not particularly useful in groundwater management. Instead, useable storage can be calculated to reflect how much water can actually be extracted without undesirable effects (it is generally a much lower number).

A typical method of calculating useable storage is to choose a depth to which groundwater can be drained without undesirable effects and multiplying the aquifer volume to that depth by the percentage of drainable pore space in the aquifer ("specific yield"). Specific yield varies by aquifer and area, but is commonly in the range of 10% to 20%.

Historical calculations of usable storage in the Goleta Groundwater Basin have varied somewhat on the assumptions used in the calculation. Toups (1974) estimated the storage at 200,000 acre-feet for the upper 400 feet of saturated sediments, with usable storage between 40,000 and 60,000 acre-feet. Those storage numbers are what are currently being reported in DWR Bulletin 118 (DWR, 2009).

In work done by CH2MHill and used by GWD, usable storage down to historical low water levels was calculated at 30,000 to 60,000 acre-feet (CH2MHill, 2005; GWD, 2008). In addition, there is another 10,000 to 20,000 acre-feet of currently-dewatered aquifer that could be filled (CH2MHill, 2005; GWD, 2008). If the conservative assumption is used that groundwater elevations should not go below historical lows (we know that no undesirable effects occurred at this level), then the total storage that can be worked with is between 40,000 and 80,000 acre-feet. The majority of this storage is in the Central and North subbasins. The current amount of water stored in the basin by GWD and La Cumbre is just over 44,000 acre-feet (see section 4.4.1-*Groundwater Storage Programs*), within the estimated range of useable storage. The amount of manageable storage in the Goleta Groundwater Basin allows flexibility in drought

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[7] The Court in the Wright Judgment defined the perennial yield as including 350 acre-feet per year for the GWD well injection system and 100 acre-feet per year of return flow (applied water that percolates back to the aquifer).

planning. Specific management strategies are discussed in the section 5-*Future Management Strategies*.

4.3 Technical Components of the Plan

There are a number of technical components that can be included in a groundwater management plan[8]. These components include:

1. The control of saline water intrusion.
2. Identification and management of wellhead protection areas and recharge areas.
3. Regulation of the migration of contaminated groundwater.
4. The administration of a well abandonment and well destruction program.
5. Mitigation of conditions of overdraft.
6. Replenishment of groundwater extracted by water producers.
7. Monitoring of groundwater levels and storage.
8. Facilitating conjunctive use operations.
9. Identification of well construction policies.
10. The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling and extraction projects.
11. The development of relationships with state and federal regulatory agencies.
12. The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

Some of these components are under the jurisdiction of other agencies or are not applicable to the Goleta Groundwater Basin. The following components are considered in this Groundwater Management Plan:

- Control of saline intrusion
- Mitigation of overdraft
- Replenishment of groundwater
- Monitoring
- Conjunctive use
- Operation of recharge, storage, water recycling, and extraction projects

These technical components are integrated into a number of management strategies for the basin.

4.4 Current Management Strategies

Management strategies are the methods to implement the Groundwater Management Plan. The discussion of these strategies is divided into two parts – current strategies (this section) and recommended future strategies (section 5 – *Recommended Future Strategies*).

4.4.1 Groundwater Storage Programs

The current strategy for groundwater storage in the basin follows both the Wright Judgment (for GWD and La Cumbre) and the SAFE Ordinance (for GWD). For both

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[8] California Water Code section 10753.7.

purveyors, the storage strategy has used both in-lieu recharge (using another water source to reduce pumping and letting the basin refill) and direct well injection. GWD has pumped a minimal amount from the basin since the early 1990s, allowing the basin to refill. La Cumbre has pumped below their water right over the past 10 years, also allowing the basin to refill.

GWD has delivered a portion of its Cachuma spill water (water that would otherwise have spilled from the dam during a wet period when Cachuma was full) to La Cumbre for recharge to Goleta's benefit (Table 4-2). This spill water has been used by La Cumbre to offset their own pumping and for direct injection in La Cumbre's wells. Since the beginning of 1999, GWD was required by the Wright Judgment to offer to deliver 20% of Goleta's treated spill water to La Cumbre at GWD's actual cost. If the offer is not accepted, GWD may use La Cumbre's wells for injection of water into the basin. La Cumbre has used their share of this spill water to offset pumping and, most recently, for direct injection (Table 4-3). Total water in storage for GWD and La Cumbre at the end of 2009 was in excess of 44,000 acre-feet.

Year	*Water Right (AFY)*[9]	*Pumping (AF)*	*Injection (AF)*[10]	*Annual Storage (AFY)*	*Cumulative Storage (AF)*
1992	2,023	13		2,010	2,010
1993	2,037		1,422	3,459	5,470
1994	2,051		346	2,397	7,867
1995	2,051		964	3,015	10,882
1996	2,175			2,175	13,054[11]
1997	2,224			2,224	15,272
1998	2,226	8	600	2,818	18.084
1999	2,226	8	1,595	3,807	21,891
2000	2,226		70	2,290	24,182
2001	2,226	8	405	2,623	26,805
2002	2,226	3	113	2,336	29,141
2003	2,350			2,350	31,492
2004	2,350		658	3,008	34,500
2005	2,350		668	3,018	37,518
2006	2,350		288	2,638	40,156
2007	2,350	438		1,912	42,068
2008	2,350	1,888	334	796	42,864
2009	2,350	1,987	26	389	43,253

Table 4-2. GWD groundwater storage in Central subbasin (in acre-feet) under the Wright Judgment.

Calculation of storage under the Wright Judgment uses a different method of calculation for La Cumbre than for GWD. For La Cumbre, a 10-year moving average of pumping is used to allow annual pumping to vary above and below the water right of 1,000 acre-feet per year to accommodate wet and dry periods. In Table 4-3, the water available to pump above the water right is tracked in the 10-Yr Accumulated Unused

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[9] Includes increased groundwater rights from both exchanges and augmented service (see Table 1-1).
[10] From GWD annual reports to the Court and other Parties to the Judgment.
[11] Several years have slight deduction for delivery to non-parties.

Water column. In 2009, the 1999 data dropped off the calculation so that only the most recent ten years were used in the calculation. The exception to this is water stored by injection into the aquifer – this storage accumulates until it is pumped back out.

Calendar Year	*Water Right*	*Pumping*	*Unused Water Right*	*10-Yr Accumulated Unused Water*	*Injection Storage*	*Cumulative Injection Storage*
1999	1,000	893	107	107		
2000	1,000	533	467	574	27	27
2001	1,000	394	606	1,180	98	125
2002	1,000	969	31	1,211		125
2003	1,000	765	235	1,446		125
2004	1,000	1,095	-95	1,351		125
2005	1,000	766	234	1,586	424	549
2006	1,000	786	214	1,800	81	631
2007	1,000	1,096	-96	1,704		631
2008	1,000	957	43	1,747	150	781
2009	1,000	953	47	1,687		781

Table 4-3. La Cumbre water rights and groundwater storage in Central subbasin (in acre-feet). La Cumbre was first allowed by the Wright Judgment to store water in 1999. Pumping can vary annually as long as the average of the most recent ten years does not exceed 1,000 acre-feet per year. 2009 was the first year where the moving average dropped a year, 1999, as the ten-year average was calculated using years 2000-2009.

The SAFE Ordinance, which applies only to GWD, provides for the creation of a Drought Buffer of water stored in the Goleta groundwater basin to protect against future drought emergencies. When groundwater elevations are below 1972 levels (interpreted in this Plan as the average of the Index Wells in any year being below the average in 1972), SAFE specifies that a certain amount of water must be committed to be recharged to the basin during each year (see section 1.3 – *SAFE Ordinance (GWD)*). The amount of water required to be stored annually under these conditions is GWD's basic water right (2,000 acre-feet per year) plus ⅔ of the amount of any new service (Table 4-4). SAFE specifies that any State Water delivered to GWD in excess of 3,800 acre-feet per year must be recharged to the basin. The annual storage commitment and State Water delivery to recharge are not required to be made in any year when groundwater elevations are above 1972 levels (Table 4-5).

The Wright Judgment and the SAFE Ordinance interact to a degree (for GWD), which is discussed further in section 5.6 – *Interaction of Wright Judgment and SAFE Ordinance*.

Year	Base Annual Storage Commitment (AFY)	New Service (AF)	New Service Storage Commitment (AFY)[12]	Annual Storage Commitment (AFY)[13]
1997	2,000	165	110	2,110
1998	2,000	96	64	2,174
1999	2,000	13	9	2,183
2000	2,000	21	14	2,197
2001	2,000	33	22	2,219
2002	2,000	31	21	2,240
2003	2,000	11	8	2,248
2004	2,000	24	16	2,263
2005	2,000	45	30	2,294
2006	2,000	26	17	2,311
2007	2,000	77	51	2,362
2008	2,000	9	6	2,368
2009	2,000	7	5	2,373

Table 4-4. GWD required annual commitment to storage under the SAFE Ordinance. The storage requirement for new service is additive of previous storage requirements because the new demand is present in subsequent years and must be protected using the Drought Buffer.

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[12] ⅔ of the New Service demand is added to the Base Contribution.

[13] The Annual Storage Contribution is calculated each year. It is only required to be contributed when groundwater elevations are below 1972 levels. Note that calculations have been rounded so additions of columns may appear to be erroneous (but they aren't).

Year	Annual Storage Commitment Calculation (AFY)	Required Annual Storage Commitment (AFY)[14]	Water Stored Under Commitment (AFY)	Annual Commitment Outstanding (AF)
1997	2,110	2,110	2,110	0
1998	2,174	2,174	2,174	0
1999	2,183	2,183	2,183	0
2000	2,197	2,197	2,197	0
2001	2,219	2,219	2,219	0
2002	2,240	2,240	2,240	0
2003	2,248	2,248	2,248	0
2004	2,263	2,263	2,263	0
2005	2,294	0	0	0
2006	2,311	0	0	0
2007	2,362	0	0	0
2008	2,368	0	0	0
2009	2,373	0	0	0

Table 4-5. GWD required annual storage commitment under SAFE, indicating actual recharge and any outstanding commitment that has not yet been recharged. GWD has satisfied all required storage commitments through 2009. No contribution has been required since 2004 because groundwater elevations have been above 1972 levels.

There are limits to how much the basin can continue to be filled. Available unused storage in the basin as of 2008 has been calculated to range from 10,000 to 20,000 acre-feet (see section 4.2.2-*Basin Storage*). That remaining storage could be filled in less than a decade if there was no intervening drought. It is not clear what unintended consequences would occur if the basin was filled to levels unseen in decades; possible consequences could be reactivation of springs, flooding of foundations and shallow excavations, unwanted flow from wells that are not equipped to withstand artesian conditions, leaking of abandoned wells that were improperly destroyed, and interference with groundwater cleanup operations.

4.4.2 Groundwater Pumping

The current strategy for pumping in the basin is to stay within water rights determined by the Wright Judgment, allow the basin to recover by reducing pumping when possible, and store un-pumped groundwater for a drought or some other water contingency. GWD is currently pumping groundwater for just such a contingency, to dilute water from Lake Cachuma that has increased organic matter and subsequently higher disinfection byproducts caused by erosion in the Cachuma watershed burned in the Zaca fire.

La Cumbre has pumped groundwater somewhat below their water right over the last decade (Table 4-3), whereas GWD's pumping has been reduced to a minimum since the early 1990s to allow the basin to refill (Table 4-2). As a result of the reduced pumping,

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[14] After 2004, GWD Board determined that groundwater elevations were above 1972 levels, so no Annual Commitment was required.

groundwater elevations in much of the Central subbasin have been rising for years. Near-surface elevations in the West subbasin may also be related to this reduced pumping. Current pumping strategies do not address the long-term management of these groundwater elevations.

In the eastern portion of the Central subbasin, where groundwater elevations are lower than elsewhere in the subbasin (Figure 2-2), La Cumbre pumping balances water quality concerns against costs – groundwater is less expensive than State Water, but the surface water (State Water flows through Cachuma reservoir during delivery) is usually better quality.

4.4.3 Groundwater Monitoring

The existing regional groundwater level monitoring program, conducted by the U.S. Geological Survey and contracted by GWD, consists of collecting manual measurements of water levels in 47 basin wells twice a year: 35 wells in the Central subbasin, 6 in the North subbasin, and 4 in the West subbasin. A few of these wells are close to purveyors' wells, limiting their usefulness when the supply wells are being pumped. The monitoring is currently conducted in June and December of each year. The location and elevation of the wells were surveyed in 2008. These wells, along with their construction details, have been entered into a Geographic Information System (GIS) database as part of preparing this Plan. Groundwater elevation records, including historic records as far back as the 1920s, are in digital form.

In addition, purveyors' wells are commonly fitted with pressure transducers as part of their automated SCADA system; water levels measured by the transducers are preserved digitally. GWD is currently placing several pressure transducers in additional wells.

Regional groundwater quality is not currently regularly monitored outside of the purveyors' required drinking water monitoring. Historical water quality data is more complete (e.g., compare Figure 3-1 to Figure 3-7). Both historic and current water quality data have been entered into a digital database as part of preparing this Plan.

4.4.4 Groundwater Modeling

A groundwater flow model has been constructed for the Goleta Groundwater Basin (CH2MHill, 2009b). The model calculates groundwater elevations through time that would result from changes in pumping. As currently constructed, the model can be used to determine future well locations in the Central basin.

4.4.5 Wellhead Protection

A Drinking Water Source Assessment is required by the California Department of Public Health (DPH) for each of the purveyors' public water supply wells. Purveyors were given the option of doing the Assessment themselves or having DPH do the Assessment. In the Goleta Groundwater Basin, DPH conducted the Assessments for the purveyors. They are on file with DPH and the purveyors. The Assessment evaluates the contamination potential for the aquifers from overlying uses ranging from leaking gasoline tanks to concentrated farm animals. Most of the purveyors' wells are relatively well protected because water is produced from confined aquifers, where low-transmissive beds such as clays separate surface contamination sources from the deeper aquifers.

4.4.6 Cooperation with Other Agencies

South Coast water agencies belong to regional water organizations, depending upon their sources of water. GWD is a member of the Cachuma Operations and Maintenance Board (COMB) and Cachuma Conservation Release Board (CCRB) along with the other agencies who receive water from Lake Cachuma. GWD and La Cumbre are member and associate member agencies, respectively, of the Central Coast Water Authority (CCWA), their State Water contractor. GWD and La Cumbre coordinate as needed with the City of Santa Barbara on issues related to water delivery and interties.

5 Recommended Future Strategies

5.1 Semi-Annual Monitoring of Groundwater Elevations

The semi-annual monitoring conducted by the U.S. Geological Survey (under contract to GWD) is an essential element of basin monitoring. Semi-annual monitoring is generally designed so that annual high and low groundwater elevations in the basin are determined. Current monitoring occurs in the months of June and December.

To evaluate whether June and December are the optimum monitoring months to detect annual high and low groundwater levels, both historical groundwater measurements and automated measurements from GWD's production wells (SCADA data) were analyzed. Using all the available historical water level data for which there are at least 6 measurements per year in a single well (this happened prior to the current USGS monitoring of twice a year), Figure 5-1 shows the months in which the high and low groundwater levels were measured for each year. The month in which wells in the Central subbasin recorded the largest frequency of high water levels was April, whereas the month with the most low water levels was December. There is a significant variation from year to year in the month in which high and low groundwater levels were recorded, likely reflecting annual differences in rainfall timing and magnitude, the lag time for recharge to reach individual wells, and local pumping patterns.

A similar analysis of historical water level records in the North and West subbasins (Figure 5-2 and Figure 5-3) yielded somewhat different results. In the North subbasin, highs and lows were in June and December, respectively. In the West subbasin, highs and lows were in April and October, although the number of samples was relatively small.

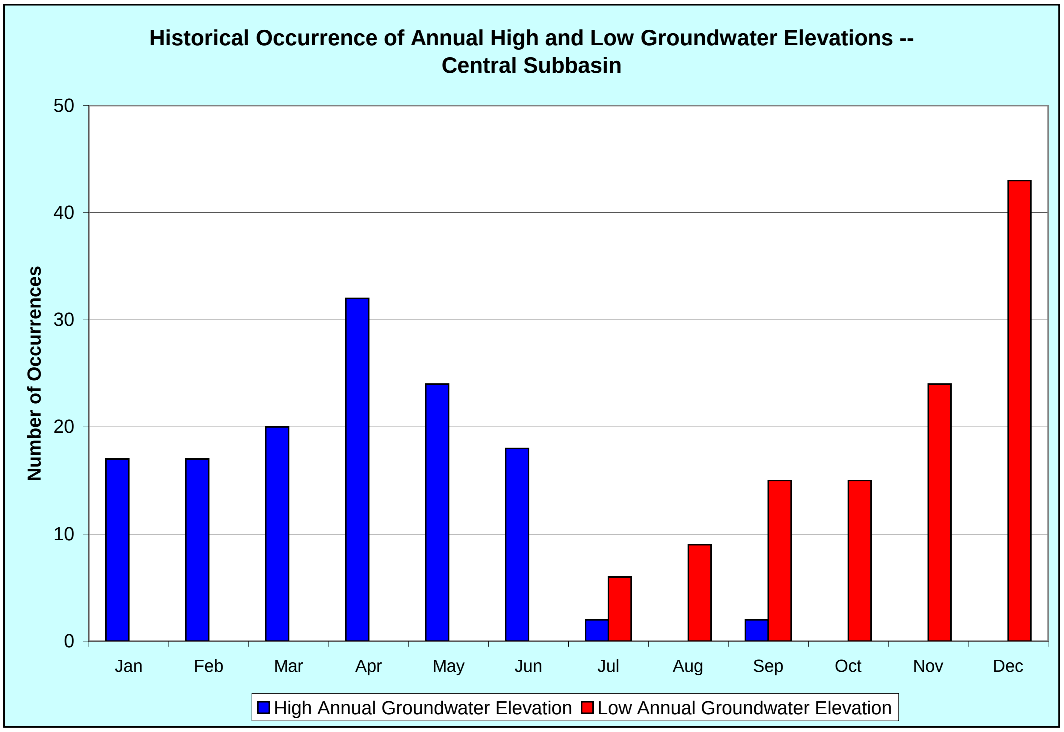

Figure 5-1. **Months in which annual high and low groundwater elevations occurred, based on historical measurements from the Goleta Central subbasin.**

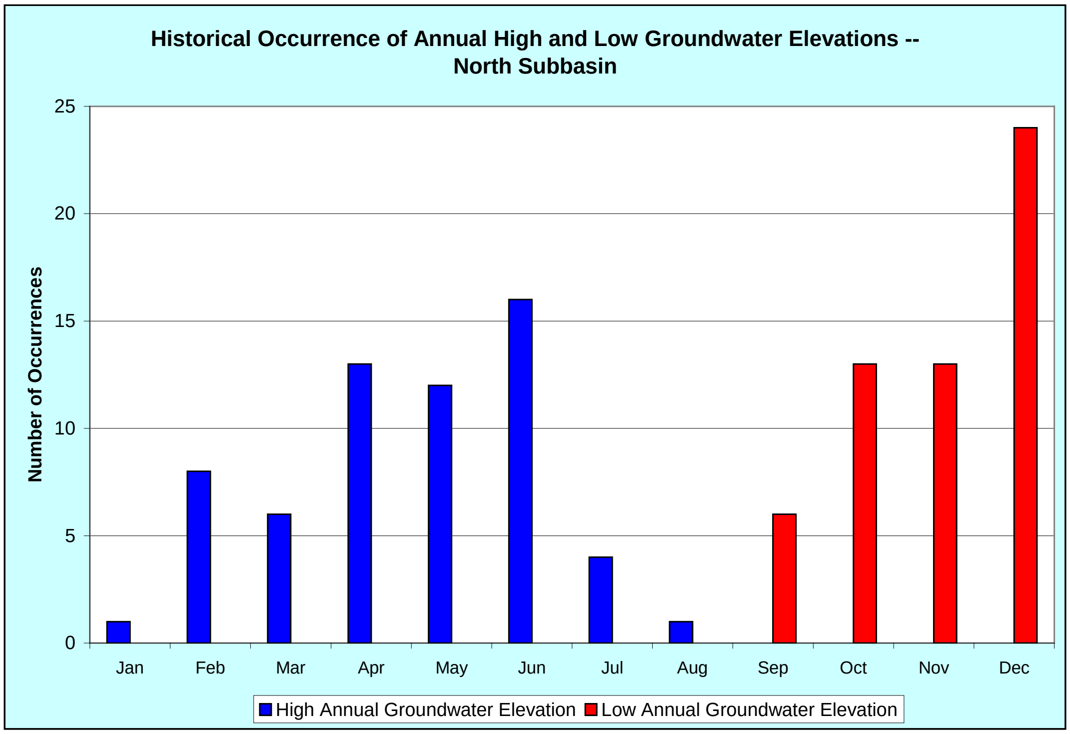

Figure 5-2. **Months in which annual high and low groundwater elevations occurred, based on historical measurements from the Goleta North subbasin.**

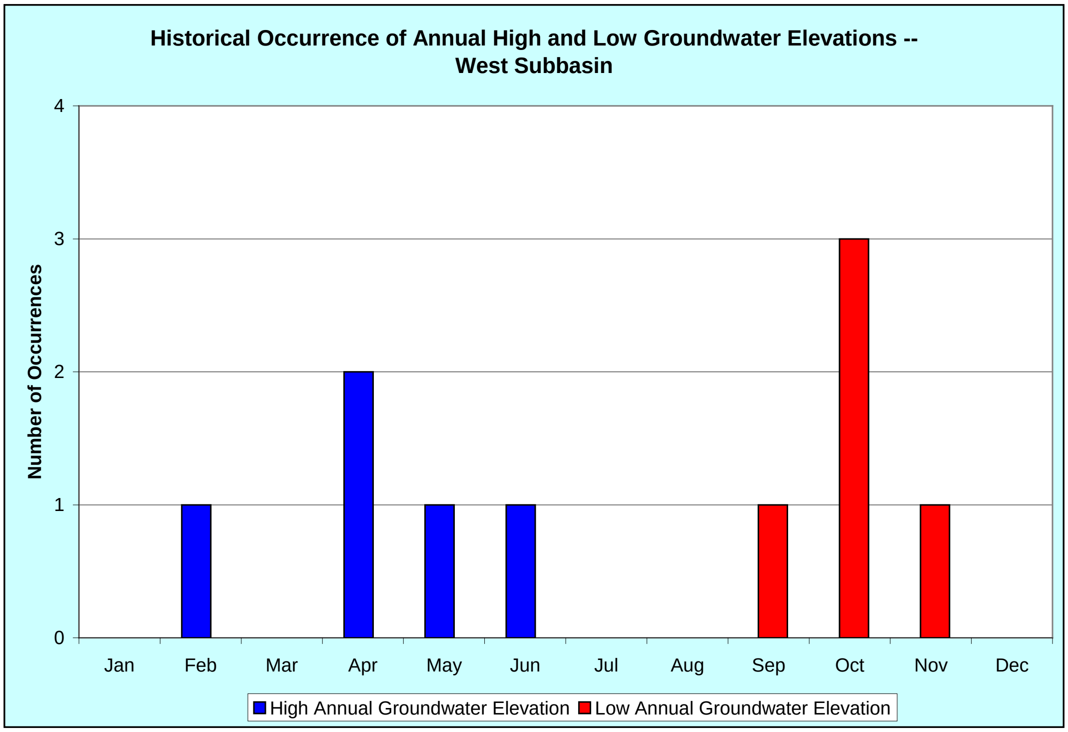

Figure 5-3. Months in which annual high and low groundwater elevations occurred, based on historical measurements from the Goleta West subbasin.

The historical record of high-frequency measurements of groundwater elevations in the Goleta Groundwater Basin is biased towards the 1970s and 1980s. To determine the timing of current high and low groundwater levels, data from GWD's automated measurements in producing wells (SCADA system) were used (Figure 5-4). The SCADA results indicate both depth to water in the well and the current rate of pumping. Using non-pumping water levels from the San Antonio well and discounting the periods of injection, high annual water levels occurred in March (blue arrows) and low annual water levels occur in August and September (red arrows). The measurements vary considerably over a short period of time because the pump is turning off and on, and some of the measured water levels have not recovered fully from a pumping cycle.

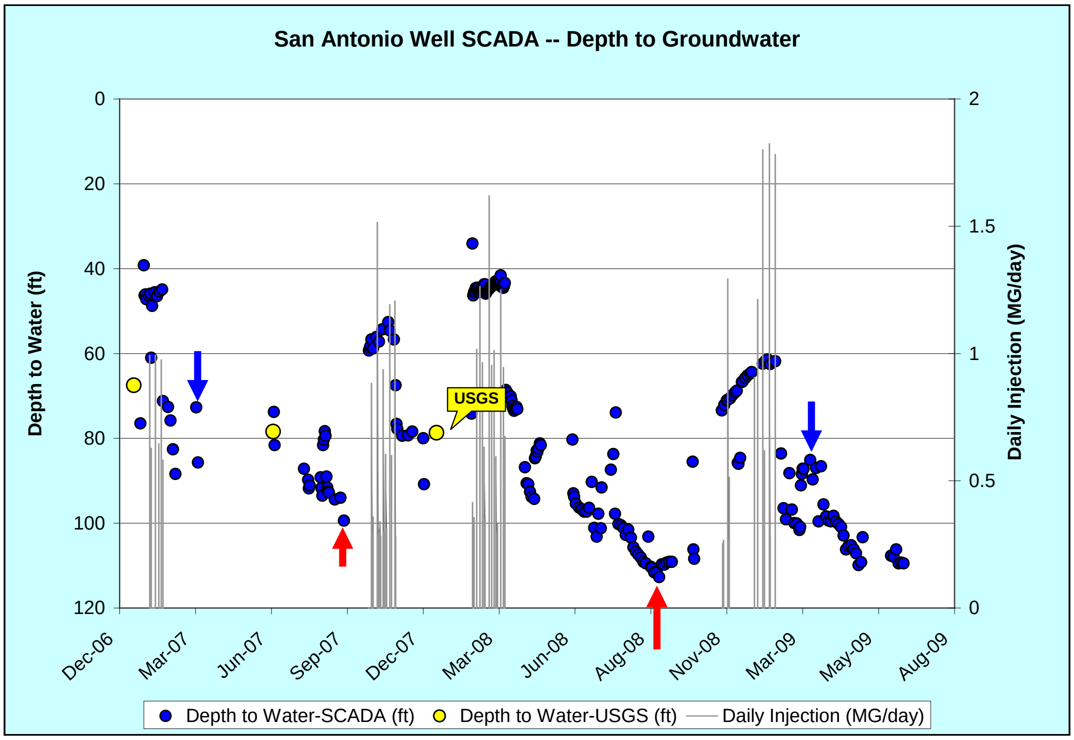

Figure 5-4. Automated depth to water measurements in GWD's San Antonio producing well from SCADA records. Water levels shown are for periods when the well was not pumping (but may still be affected by pumping). Blue arrows indicate annual high in groundwater elevations and red arrows indicate annual low. Manual measurements made by the U.S. Geological Survey are also shown.

There is a clear difference in the timing of annual high and low groundwater elevations between historical measurements and current automated measurements. Given the uncertainty in using data from a well that is pumping much of the time, it is recommended that the historical data be used as the basis for determining the months to monitor groundwater elevations. Thus, monitoring should take place in April and December. When information from the additional transducers is obtained (see below), this schedule can be modified as needed. This change in monitoring schedule should not affect comparisons to 1972 groundwater elevations (as part of the SAFE Ordinance) because 1972 measurements were largely conducted on a once-a-month schedule.

When the April and December water levels are measured, it is important to ensure that the measured well (if it is a pumping well) and nearby wells have not been pumped during the previous 12 hours or so. The SCADA data from GWD producing wells indicate that it takes about 10 hours in these wells for groundwater levels to recover (equilibrate to a constant level) after a pumping cycle is completed.

5.2 Additional Monitoring Points

There has been a recommendation to increase the number of monitoring points in the southeastern portion of the Central subbasin, where basin water levels are lowest, by adding as many as four additional monitoring wells (CH2MHill, 2009a). As shown on

Figure 2-2, there are few monitoring points in this area. It is recommended that at least two existing wells in this area be considered for water level monitoring. An additional monitoring point should be considered as a new dedicated monitoring site, with nested wells each of which are completed (perforated) at different depths in the aquifer (a typical nested monitoring site). Such a nested monitoring site provides different information than a production well, which is typically completed (open to the aquifer) over a large depth interval. A multiple completion monitoring well gives specific information at different depths, which helps define the complexity of the aquifers, vertical groundwater gradients, and water quality at different depths. In many California basins, multiple completion wells have provided information that has changed basin management strategies.

It is also recommended that a multiple completion monitoring well be installed near the Goleta slough area. This well would serve as a sentinel for detecting seawater intrusion, whether from leakage across the More Ranch Fault or downward migration from surface waters.

5.3 Monitoring of Groundwater Quality

Water quality degradation is particularly problematic, because it is difficult to reverse and could require treatment of pumped groundwater. Water quality monitoring of groundwater appears to have been reduced over the past two decades. Although there does not appear to be any current threat of widespread water quality degradation, it is only with systematic monitoring that there is assurance that this continues.

Two steps are recommended to make water quality monitoring more robust. First, water quality sampling results from purveyors’ wells should be obtained from the California Department of Public Health (DPH) every two years and added to the water quality database that was created in preparing this Plan. DPH keeps digital records for all water quality sampling of public water supply wells and provides these files upon request. Second, approximately ten additional water quality monitoring sites should be added using the dedicated monitoring wells and a sampling of private wells to create a geographic distribution of monitoring sites (potential wells are listed in section 7.2 *Appendix B – Additional Water Quality Wells*. It is recommended that water quality sampling be conducted every two years, with analyses of the typical general mineral suite. The recommended multiple-completion monitoring well near the Goleta slough should be sampled annually. When water quality results are received, they should be entered in the database and analyzed for changes. If there is significant deterioration in water quality in any of the wells being monitored, then the sampling frequency for that well should be increased.

5.4 Determination of 1972 Conditions for SAFE Ordinance

A groundwater management consideration for GWD is compliance with the District’s SAFE Ordinance that sets 1972 groundwater levels in the Central subbasin as the baseline for determining a drought buffer (see section 1.3-*SAFE Ordinance*). The method for determining “1972 water levels” was not specified. Possible options include:

Method 1: All wells in the Central subbasin for which there was a water level measured in 1972 must remain higher than that level. This method does not allow any flexibility in groundwater management. For instance, if a new well was drilled in a different part of the basin to relieve pumping stress elsewhere in an area with low water levels, pumping of the new well could lower water levels below the 1972 level in the new area, which would trigger the SAFE Ordinance even if the strategy was best for the basin. In fact, this method could exacerbate undesirable effects in the basin by rigidly enforcing the pumping patterns of 1972; it is not recommended.

Method 2: Water levels measured in 1972 are used to calculate the amount of water that was in storage in 1972 in the Central subbasin. This storage volume would then be compared to the current amount of water in storage. In theory, this would be the most appropriate method, but it is problematic. As discussed in section 4.2.2-*Basin Storage*, there is a large range in aquifer properties, yielding a storage calculation with a large range. In addition, if changing groundwater elevations in wells are used to calculate changes in storage in the basin, the errors can be orders of magnitude in size depending upon whether the groundwater elevations were measured in confined or unconfined portions of the aquifers. Thus, this method is not recommended at this time.

Method 3: Water levels measured in 1972 are used together to create an average 1972 water level in the Central subbasin. Current average water levels from the same set of wells are used to compute a current average water level. This method requires that the same wells be used in 1972 and today. There are sufficient wells that meet the criterion of having 1972 measurements and current measurements. There is a choice of simply using all the wells that meet the criterion or using a subset of the wells that give an even geographic distribution. It is recommended that an even geographic distribution of wells be used.

Method 3, recommended here, is used in the two adjudicated basins closest to the Goleta Groundwater Basin. In the Santa Paula basin (Ventura County), a set of seven Key Wells are used to indicate the trend in overall groundwater elevations in the basin. In the Nipomo Mesa Management Area portion of the Santa Maria basin (Santa Barbara and San Luis Obispo counties), the average water level from a set of eight wells comprise the Key Wells Index which triggers various management events in the basin.

A consideration in determining 1972 groundwater levels is the time of year of the measurement. 1972 groundwater levels vary by more than 10 feet from the wet to the dry portion of the year. It is recommended that winter-spring groundwater elevations be used to determine average groundwater elevations. During this time, groundwater pumping is at its smallest and it is more likely that measurements represent static water levels (rather than pumping water levels) in the basin. In 1972, high groundwater elevations were generally reached in February or March. The recommended monitoring program in the basin would measure groundwater elevations in April and December (see section 5.1-*Semi-Annual Monitoring of Groundwater Elevations*), but current monitoring is conducted in June and December. For accuracy, similar months should be compared. Thus, in determining groundwater conditions for the SAFE Ordinance, June 1972 measurements should be compared to June measurements in subsequent years. This should be considered an interim comparison – when new April measurements become available in the future, then the comparison should be between April 1972 levels and April levels in subsequent years.

The U.S. Geological Survey considered criteria for selecting wells for comparison to 1972 groundwater elevations (Kaehler and others, 1997). The criteria chosen by the USGS for selection of wells were, in approximate order of importance: (1) the well is completed in the Santa Barbara Formation or younger deposits; (2) the well is located in the Central subbasin; (3) the well has water-level data for calendar year 1972; (4) the well is currently measurable; (5) water level measurements were made when the well was not being pumped; (6) the well has perforated intervals similar to those of a well measured in 1972 that was later destroyed, inaccessible, or could not be located; and (7) the wells that are selected provide a broad areal distribution of wells within the Central subbasin.

The USGS chose 17 wells at 15 sites for their 1972 comparison. Substitute wells were included among the selected wells – meaning that some wells were used that had not yet been drilled in 1972, but were used as a surrogate for a nearby 1972 well that was no longer measurable. Some of the wells chosen by the USGS were problematic (Kaehler and others, 1997), being at more than 100 feet higher elevation than all other wells or being too close to faults. Equal geographic distribution was not achieved throughout the basin, especially in the important southeastern portion of the Central subbasin. There was an average drop in groundwater elevations of almost 22 feet from 1972 to 1996 at the 15 sites.

For this Plan, a more-even geographic distribution was sought. A total of 14 wells were available in the Central subbasin which had monthly water level measurements in 1972 and are currently being monitored. A discussion of how these wells were culled to seven Index Wells is included in the Appendix. Seven wells were chosen as Index Wells based on varied construction data, geographic distribution, and completeness of the historical record between 1972 and today (Figure 5-5, Table 5-1). All of the Index Wells have monthly water level measurements in 1972, allowing a comparison with current conditions for either the month of June (interim comparison) or the month of April (recommended future spring measurements). These wells vary in their depth completions, so they likely represent a composite of groundwater conditions in the main producing zones in the basin. Because the SAFE Ordinance targeted the basin as a whole rather than a specific aquifer, this approach is consistent with the intent of SAFE.

Groundwater elevations for the seven Index Wells were used to construct a historical record for groundwater elevations in June of each year (Figure 5-6). The annual value of the Index was calculated by averaging the groundwater elevations for that June in each of the wells. Gaps appear in the historical Index when at least one of the Index Wells had no reported measurements of groundwater levels. Figure 5-6 indicates that the Index rose above the 1972 value starting in 2002, and is currently more than 20 feet above the 1972 Index.

It is also helpful to know the low point in the Index during the low groundwater elevations in the drought of the late 1980s and early 1990s. To determine this, the Index was extended by reconstructing data in the missing years. To approximate a missing groundwater elevation measurement in a particular well, groundwater elevations in that well and nearby wells with no missing measurements were cross-correlated for the periods when there were measurements in both wells. The resulting correlation was used to calculate the June groundwater elevation in the unmeasured well. This cross-correlation method is explained in more detail in the Appendix. The results of this reconstruction are shown on Figure 5-7. Figure 5-7 indicates that the low Index value occurred in 1989, with an Index value of -85 feet.

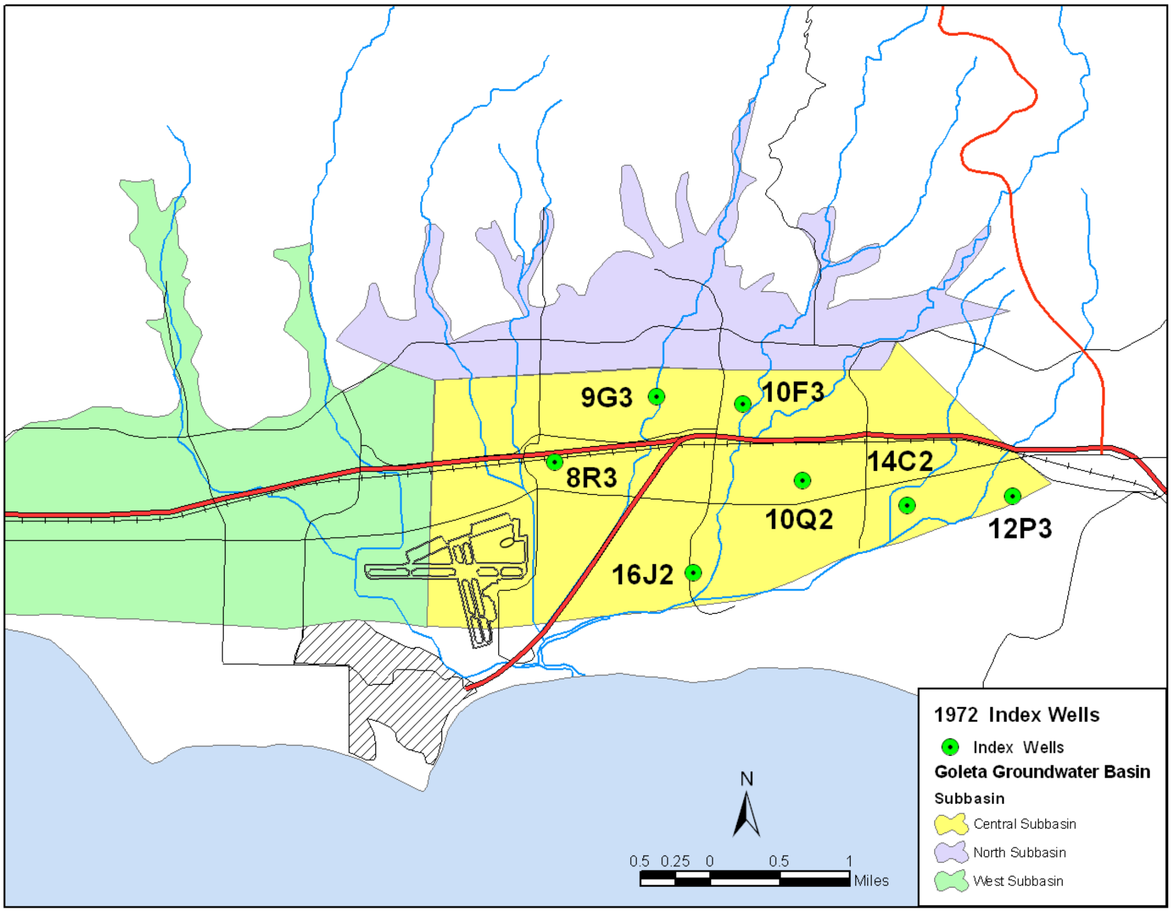

Figure 5-5. Location of Index Wells for determination of SAFE Ordinance 1972 groundwater elevations.

Well Number	*Name*	*Depth*	*Perforations*	*Years of Record*
04N28W08R03	Magnolia	106'	N/A	1941-current
04N28W09G03	GWD Berkeley #1	288'	168'-288'	1964-current
04N28W10F03	GWD Barquero	300'	150'-300'	1970-current
04N28W10Q02	Emmons	278'	62'-278'	1922-current
04N28W12P03	La Cumbre MWC #7	626'	115'-626'	1947-current
04N28W14C02	La Cumbre MWC #17	544'	275'-535'	1938-current
04N28W16J02	Ciampi #1	458'	160'-390'	1954-current

Table 5-1. Index Wells for determination of SAFE Ordinance 1972 groundwater elevations.

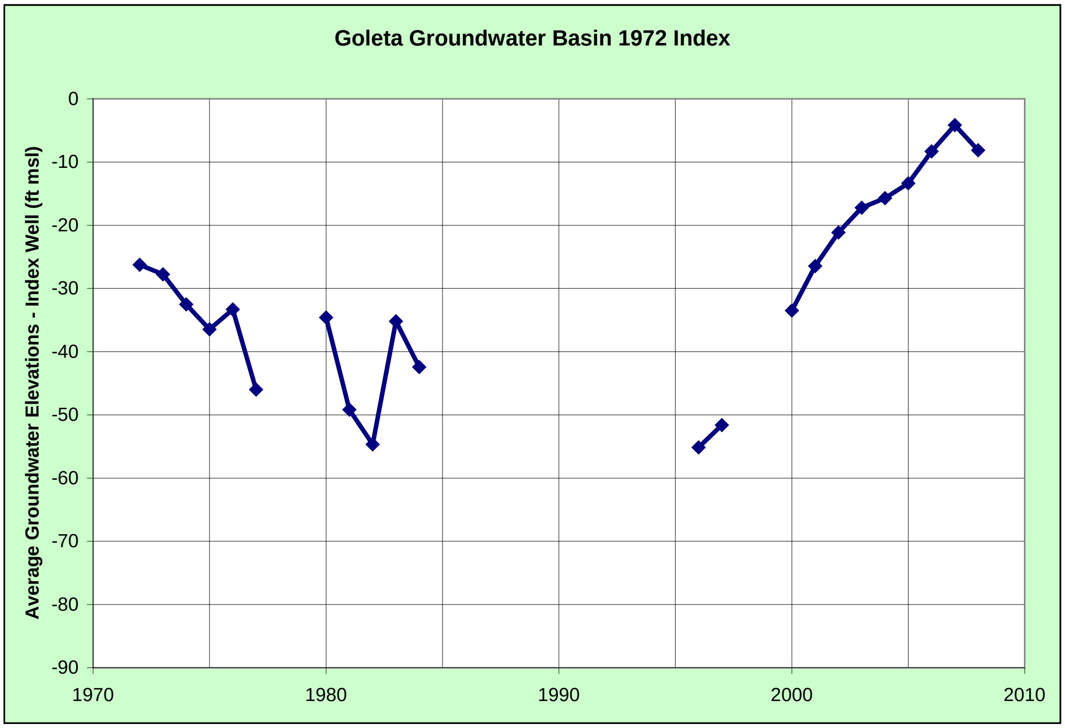

Figure 5-6. **Average June groundwater elevations for the seven Index wells in the Central subbasin. Gaps in the graph represent years when at least one of the Index wells was not monitored for groundwater elevation.**

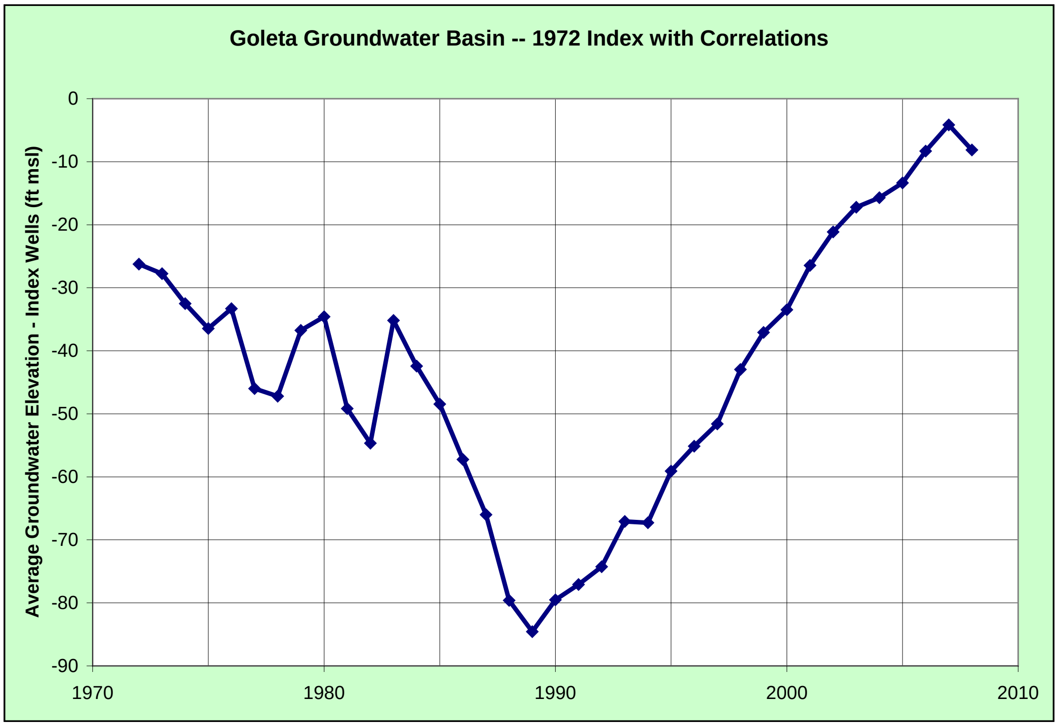

Figure 5-7. **Average June groundwater elevations for the seven Index wells in the Central subbasin, with the data gaps of Figure 5-6 partially filled by correlating groundwater elevations between wells (see text for explanation).**

5.5 Temporary Surplus

The term “Temporary Surplus” was used in the Wright Judgment as the amount of water that can extracted each year from the basin above the safe yield. There was no further discussion in Wright as to how to determine Temporary Surplus. The total amount of water that can be safely extracted from the Goleta basin consists of the safe yield, water stored by GWD and LA Cumbre, and any water that would otherwise be lost from the basin when groundwater elevations are too high. The safe yield and the amount of water in storage are discussed and calculated elsewhere in this Plan. Although groundwater elevations are currently quite high in the basin, it is not clear that any additional water is being lost from the basin as a result.

Thus, it is recommended that Temporary Surplus be considered to be the water placed in storage within the water rights of the Wright Judgment, with the rights to pump Temporary Surplus residing with the organization that stored the water. It is also recommended that the amount of water that would otherwise be lost from the basin because of high groundwater elevations be considered as zero at this time. If subsequent study indicates that there is such loss from the basin, the Basin Operating Group may find that this water can also be considered part of the Temporary Surplus until the high water condition ceases.

La Cumbre does not have any restrictions on when its portion of the Temporary Surplus water can be pumped. Because of SAFE extraction rules, GWD can pump its share of Temporary Surplus water either when groundwater elevations in the basins are above 1972 levels or when a drought on the South Coast causes a reduction in the District’s annual deliveries from Lake Cachuma.

5.6 Interaction of Wright Judgment and SAFE Ordinance

The Wright Judgment and the SAFE Ordinance (which applies to GWD only) work together, with the Wright Judgment quantifying the amount of drought storage and SAFE specifying both the quantity and timing of storage and the rules for extracting water from the drought buffer. Groundwater storage under Wright is meant to augment the basin yield assigned to La Cumbre and GWD. The water can be stored at any time using both in-lieu recharge (groundwater pumping reduced by using other sources of water) and direct injection methods. There are no restrictions in the Wright Judgment as to timing and rate of extraction of the stored water. An annual accounting of water stored under Wright is maintained by La Cumbre and GWD.

SAFE is an operational plan for GWD that augments the storage quantified in the Wright Judgment. SAFE requires a certain amount of water to be stored by GWD when groundwater elevations are below 1972 levels (see section 5.4 – *Determination of 1972 Conditions for SAFE Ordinance*). Because of SAFE extraction rules, GWD can pump its stored water either when groundwater elevations in the basins are above 1972 levels or when a drought on the South Coast causes a reduction in the District’s annual deliveries from Lake Cachuma.

	Wright Judgment	*SAFE Ordinance (GWD only)*
Annual Storage Commitment?	None	GWD requirement when groundwater elevations below 1972 levels
Limit on When Stored Water can be Pumped?	None	In years when groundwater elevations are above 1972 levels or when drought reduces Cachuma annual deliveries
Annual Limit on Quantity of Stored Water that can be Pumped?	None	None
Limit on Total Amount of Stored Water that can be Pumped?	Cannot exceed the amount stored by La Cumbre or GWD	None

Table 5-2. Differences between storage requirements for the Wright Judgment and the SAFE Ordinance.

As indicated in Table 5-2, groundwater storage under Wright is very simple – you can extract the amount that you have previously stored. It is similar to having a bank account. The SAFE Ordinance for GWD is quite different. It is not a bank account but a set of rules for storage and extraction – there is no accounting of the accumulated amount of water that is stored or extracted. The rules for SAFE are based on two criteria – whether groundwater elevations are below 1972 levels and whether Cachuma deliveries have been curtailed. SAFE creates a "Drought Buffer" by filling the basin up to 1972 levels; thus the buffer is defined not by the amount of water that was stored but by the increase in groundwater elevations that was achieved.

The SAFE Ordinance has worked well during the storage phase of the Drought Buffer. Groundwater elevations in the basin rose for almost 20 years and are currently well above 1972 levels (see Figure 5-7). However, there is an uncertainty in how it will function during certain types of shortage situations. Now that the State Project is an integral part of GWD's supplies, a disruption of those supplies would cause a shortfall in water for GWD customers. As long as Cachuma supplies are also reduced, the SAFE Ordinance works wells. However, the following situations are problematic:

1) If there is a drought in northern California but not in southern California (which has occurred in the recent past), then State Project deliveries would be reduced and Cachuma supplies may not be reduced. In this case, GWD could have insufficient supplies to fulfill its annual storage commitment, and would have to recharge the amount of the commitment at a later time when supplies are available. If the State Water deliveries are reduced severely, GWD may have insufficient supply for customers without pumping groundwater.
2) Similar to condition #1, except that State Water is reduced because of a natural disaster in northern California or a judicial restriction on deliveries.

From a groundwater management perspective, the situations outlined above are antithetic to conjunctive use of water supplies. The question then becomes whether these are realistic situations that GWD could face. Although droughts can occur in one part of the State and not the other, the duration and consequences of this scenario must be analyzed before the pumping restrictions in the SAFE Ordinance are considered problematic. GWD's Water Supply Management Plan, planned for completion in late 2010, is examining the probability and consequences of this scenario.

5.7 Groundwater Pumping Plan for Basin

Reduced pumping in the Goleta Groundwater basin over the past two decades, particularly by GWD, has allowed groundwater elevations in the basin to rise 20 feet above 1972 levels (see section 5.4-*Determination of 1972 Conditions for SAFE Ordinance*). 2008 groundwater elevations are at or very near the highest levels recorded in the basin in both the Index Wells and in other wells in all three subbasins. In fact, some wells are approaching flowing artesian conditions. Allowing groundwater elevations to rise further could cause unintended negative consequences, including leakage of groundwater to the surface in both existing and destroyed or abandoned wells. Artesian conditions in a wide area of the Oxnard Plain in 1998 caused wells to flow and abandoned wells to leak beneath roads and parking lots – one abandoned well flowed hundreds of gallons per minute from beneath the front yard of an urban house, creating neighborhood flooding for weeks until a drilling company could stop the flow.

Low groundwater elevations in the Index Wells occurred in 1989. If groundwater is pumped in the future such that groundwater elevations fall below 1989 levels (into uncharted territory), there are risks associated with that action. Risks include:

- Dewatering of fine sediments (such as clays) that serve as aquitards or are interbedded in the aquifer. This dewatering causes subsidence at the land surface, which can result in structural damage and even reversal of drainage directions. Subsidence is generally irreversible. Subsidence is common in overdrafted basins in California.
- Pulling in poor-quality water from surrounding sediments, bedrock, or along faults. Significantly lowered groundwater elevations in the coastal plain of Ventura County have induced the flow of deep oil-field brines into overlying aquifers.
- Although it appears that a bedrock high beneath the Goleta Slough protects the Goleta Groundwater basin from intrusion of seawater, the lowering of groundwater elevations at the coast could allow seawater to intrude through yet-unknown paths. If seawater was introduced into the aquifers, management of the basin would have to change significantly to ensure that no further landward movement of the salts occurred. Such management would likely include further limitations on future pumping.

Given the potential difficulties when groundwater elevations are allowed to rise too high or fall too low, there appears to be a range of groundwater elevations over which the basin should be managed (Figure 5-8):

1) Groundwater elevations between the low elevation in the Index Wells in 1989 and the 1972 elevations are within the Modified Operations range, and should be reserved for water shortage conditions (see section 5.8-*Drought Plan for Groundwater Pumping*). This range coincides with average groundwater elevations of -85 feet to -26 feet for the Index Wells.

2) Groundwater elevations between the 1972 and 2007 elevations for the Index Wells should be considered within the Normal Operations range for the basin. This range coincides with average groundwater elevations of -26 feet to -4 feet for the Index Wells.

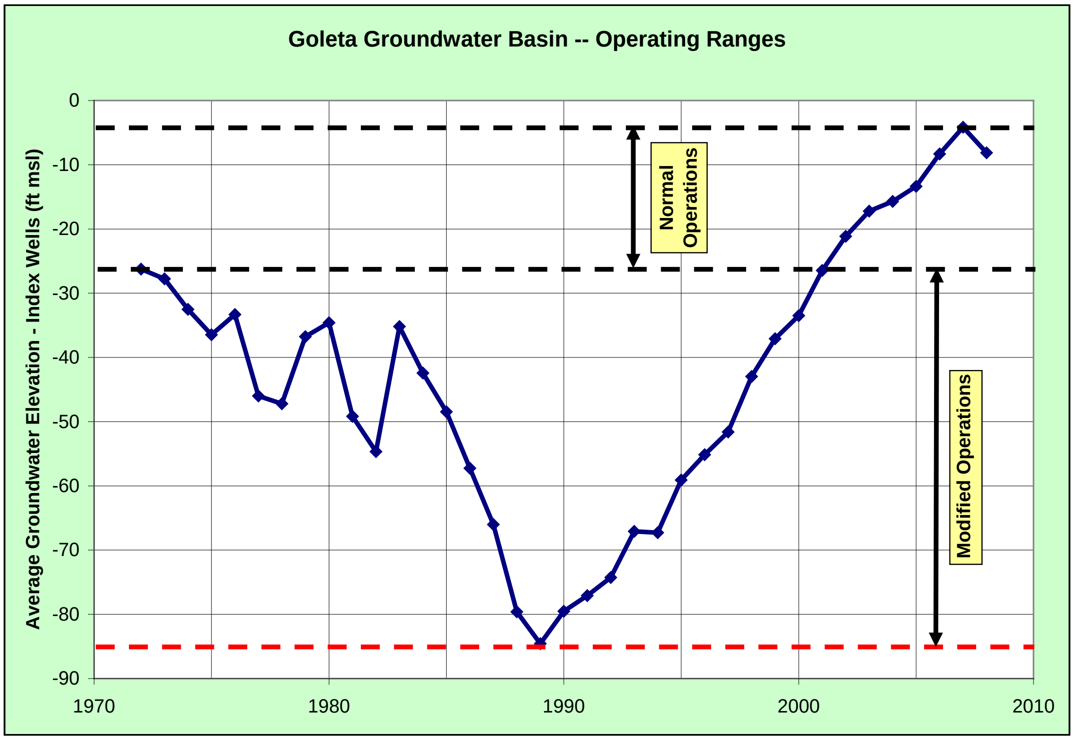

Figure 5-8. 1972 Index groundwater elevations for Normal Operations and Modified Operations in the Central subbasin.

La Cumbre is not as constrained in its operations as GWD is with the SAFE Ordinance, but the principles discussed here also broadly apply. If the basin is full, La Cumbre will also have no storage space for its share of Cachuma spill water. How the purveyors can work together on operating plans is discussed in section 5.11-*Basin Operating Group*.

A plan for the Modified Operations range is discussed in the next section. Within the Normal Operations range (Figure 5-8), the primary objectives should be retaining storage space for Cachuma spill water and reducing customers' costs. If groundwater elevations remain near the top of the Normal Operations range, there is less storage space for Cachuma spills which would otherwise flow to the ocean. Thus, storage space should be maintained by pumping groundwater in volumes close to the annual water right for the purveyors (approximately 2,000 acre-feet per year for GWD and 1,000 acre-feet per year for La Cumbre), as long as groundwater elevations remain within the Normal Operations range (this assumes that appropriate water quality can be delivered to customers).

There may be times when pumping significant groundwater does not make sense (e.g., a wet year where there is an abundance of cheaper Cachuma spill water). If groundwater elevations were maintained near the bottom of the Normal Operations range prior to the spill year(s), then the rise in groundwater elevations caused by reduced pumping and storage of spill water is less likely to overfill the basin. Following the spill year(s), groundwater elevations can be lowered by resuming groundwater pumping.

5.8 Drought Plan for Groundwater Pumping

The combination of the Wright Judgment’s groundwater storage component and GWD’s SAFE Ordinance has established a large storage bank in the Central subbasin for droughts and other potential shortages of supply. The amount of groundwater La Cumbre can pump from the storage programs cannot exceed the amount of water it has stored in the basin (although it can pump additional water from its water right as long as the ten-year moving average of pumping does not exceed 1,000 acre-feet per year). La Cumbre will likely pump from its share of the groundwater storage when State Water deliveries are curtailed because of drought conditions in northern California or some other disruption to supply.

GWD’s use of groundwater in storage is controlled by both the SAFE Ordinance and the Wright Judgment. The Wright Judgment only requires that there is storage available that was accumulated by either injection in wells or by deliveries of other supplies in lieu of pumping GWD water right. Specified effects of increased GWD pumping on other pumpers would also need to be mitigated. The SAFE Ordinance is more restrictive, limiting pumping of stored water in some circumstance (see discussion in section 5.6 – *Interaction of Wright Judgment and SAFE Ordinance*).

The length of a drought over which the buffer will provide adequate supplies depends upon whether the drought is restricted to northern or southern California, or is a State-wide drought. Over the past century or so, about half the droughts have been regional and half have been State-wide. The biggest stress on local water supplies occurs when both the State Water Project and Cachuma Reservoir are experiencing drought.

The effectiveness of drought protection in the basin can be estimated either using the expected decline in groundwater elevations when the stored water is pumped during a drought or using the annual volume withdrawn during a drought.

Method 1: During the 1986-91 drought, there was about an 8 foot per year decline in groundwater elevations in the Index Wells when about 2,500 acre-feet per year of groundwater were pumped above the current water right (2,000 acre-feet per year current GWD water right plus 2,500 acre-feet per year above that for a total of 4,500 acre-feet per year pumped by GWD – see Figure 3-21). Because the Modified Operations zone (between 1972 and 1989 groundwater elevations) encompasses a range of 59 feet of groundwater elevation for the Index Wells, stored water could be pumped for 7.4 years if groundwater elevations dropped 8 feet per year (Table 5-3). Pumping more or less than the 2,500 acre-feet per year of extra groundwater above current water rights would shorten or lengthen that time, respectively. Now that State Water is available, that water could lengthen the effectiveness of drought protection by providing a supplemental supply to groundwater. In addition, water conservation, either through voluntary or mandated actions, could substantially lengthen the effectiveness of the Drought Buffer.

Method of Estimation	*Additional Drought Pumping (AFY)*	*Annual Decline*	*Drought Buffer (Yr)*
Drought 1986-91	2,500	8 ft/yr	7.4

Table 5-3. Method 1. Decline in groundwater elevations method to estimate the number of years that the Drought Buffer would have storage available in a drought. The details of the methods are discussed in the text. If an additional 2,500 acre-feet per year were extracted every year of a drought (equivalent to the drought of 1986-91), then the Drought Buffer would provide drought protection for 7 years.

The advantage of this first method of determining the length of time that the stored water would be effective is that the rate of decline was measured during a drought when two factors combined to decrease water levels – increased pumping and reduced recharge to the basin. This circumstance is likely to occur again in the next drought.

Method 2: In this method, the volume of stored groundwater is used and the annual withdrawal from storage determines the length of time that there would be an additional drought supply. Using the amount of water stored in the basin by GWD and La Cumbre (34,000 acre-feet) as the volume of additional water that could be pumped in a drought, the number of years that this stored water could be utilized depends upon the annual amount of pumping.

In this method, there is an extra 2,500 acre-feet per year pumped from the basin for illustrative purposes. A simple calculation is that it would take over 13 years to deplete the stored groundwater (Table 5-4). The missing element in this method is the concurrent reduction in recharge that occurs in the basin during a drought. Thus, Method #1 suggests that groundwater elevations would drop to near historical low levels in a little over 7 years, even though the stored groundwater was only partially used. The 7-year estimate is the most likely outcome, because it factors in the loss of recharge, as well as the additional 2,500 acre-feet per year of groundwater pumping.

Method of Estimation	*Additional Drought Pumping (AFY)*	*Drought Protection (Yr)*
Volume of Stored Water	2,500	13.6

Table 5-4. Method 2. Volume in stored water method to estimate the number of years that the stored water could supplement supplies in a drought. The details of the method are discussed in the text. It is likely that groundwater elevations would reach historical low levels before the stored water is exhausted.

Although droughts in historical experience in southern California have not lasted continuously for decades, there is certainly ample evidence from tree ring studies that longer droughts have occurred in the past several thousand years. If a longer drought occurred in California, water purveyors who pump groundwater would be in a much better position than those who rely solely on surface water supplies. It would be prudent to discuss some strategies for the Goleta Groundwater Basin if a very long drought occurred.

An extended drought might require pumping groundwater to below historical elevations. The potential risks of pumping groundwater below historical-low elevations are discussed in section 5.7-*Groundwater Pumping Plan for Basin*. In addition, it is also likely that production yields for individual wells will decrease as groundwater elevations decrease. This relationship was detected during the drought of 1986-1991, when production capacity from GWD's wells dropped by a third over a period of five years as groundwater elevations dropped to their historical low (GWD, 1988).

If pumping below the historical low groundwater elevations is contemplated in the future, increased monitoring would be necessary to detect potential problems in the basin. A rule of thumb for increasing pumping in a coastal basin is to move the pumping inland, away from the potential source of seawater intrusion. Equally important is to increase monitoring to detect any potential undesirable effects from the pumping. This monitoring should include increased water quality measurements near the area of pumping, periodic measurements to detect ground-surface subsidence, and increased water quality measurements near the coastline. If there are insufficient wells for monitoring, dedicated monitoring wells should be installed. The cost of new monitoring wells is small compared to future costs if the aquifer is damaged.

5.9 Confirm Basin Hydrogeology

Although there has been significant work done on understanding the basin, there are some aspects of the basin that are not well understood. For example, there are various opinions on the extent of confining layers in the basin. The location of confining conditions is important because in these areas the aquifers are protected from contamination from overlying sources, which could range from leaking gasoline tanks to intrusion of saline waters during sea level rises. It is recommended that a long-term plan be formulated to prioritize and address potential unknowns in the basin. Portions of the plan could then be implemented as funding or grants become available.

5.10 Shifting of Pumping Locations

It may be advantageous to shift the location of some pumping away from the southeastern portion of the Central subbasin (this may only be practical for GWD). Such a shift would move pumping from an area of the basin where there are lowered groundwater elevations (Figure 2-2) to areas with higher groundwater elevations. Such a shift would allow groundwater elevations to recover in the lowered areas, better balancing the basin and potentially preventing such problems as future water quality degradation in the areas of lowered groundwater elevations. It is recommended that the groundwater model be used to evaluate the effect of relocating some pumping to different portions of the basin.

5.11 Basin Operating Group

There are a number of issues in the Goleta Groundwater Basin that require regular attention. These include:

- Coordination of plans for pumping and storage;
- Annual accounting for water in storage;
- Analysis and discussion of latest changes in Index Wells and Index;
- Determination of whether basin is in normal operating mode or drought mode;
- In a drought, annual reviews of amount of storage remaining and (later in a drought) planning for potential pumping below Drought Buffer;
- Review of water quality data to determine if pumping patterns are causing undesirable effects in the basin.

It is recommended that a Basin Operating Group of the staff of La Cumbre and GWD be formed to deal with these issues. It is probably sufficient that the committee meet semi-annually, with the frequency increased during a drought or if there is a problem in the basin. It is recommended that the chair of the group be rotated bi-annually between GWD and La Cumbre. This committee is not envisioned as an additional layer of governance in the basin – it would play an advisory role to basin purveyors and groundwater pumpers.

5.12 Global Climate Change Considerations

Modeling of long-term climate change is problematic at best. There is general agreement that California will be warmer, which has several potential impacts. The effect on precipitation patterns is not entirely clear. The U.S. Global Change Research Program (2009) predicts lower rainfall and longer droughts in the southwestern United States. Ongoing studies by the California Department of Water Resources (e.g., DWR, 2006) indicate that rainfall in southern California will not change significantly, with climate modeling indicating that precipitation will increase in wet years in the Sierra, but decrease in dry years. This modeling suggests that these effects will likely be less than a 10% swing in precipitation in either direction.

The four largest potential effects for the Goleta Groundwater basin are from higher overall temperatures:

- Higher temperatures will increase evapotranspiration and likely cause an increase in outside water use and crop irrigation;
- Periodic drought periods may be longer in duration, affecting recharge to the groundwater basin, runoff into Cachuma Reservoir, and water availability from the State Water Project;
- A projected sea level rise of three to six feet during this century would potentially allow the sea to encroach farther up the Goleta Slough and extend

the estuary over portions of the West and Central subbasins. This encroachment will likely occur over the portions of the basin that are under confined conditions – that is, there are low-permeability sediments that separate the estuary at the surface from the drinking water aquifers at depth. Thus, it is unlikely that this encroachment would allow saline water into the aquifers. However, such encroachment would require additional monitoring wells to be installed to ensure that downward percolation of saline waters does not occur. Preventing the encroachment of the ocean onto coastal plains around the world will be a major effort – it will be expensive and disruptive. It is not known at this time if the Goleta Slough area would be protected from encroachment in the future as part of this global effort.

- More of the winter precipitation in the Sierra Nevada will fall as rain instead of snow. Because Sierran dams are partially operated as flood control facilities, some of the winter rain runoff will have to be released from the dams to preserve storage space for later storm events, effectively reducing winter storm capture and water available for the State Water Project.

The California Department of Water Resources is currently evaluating how reservoir operations can be modified to respond to these changes. DWR updates its State Water delivery probability curves regularly; as global climate change is integrated into these curves, the recipients of State Water in the Goleta Groundwater Basin should use these updates to modify their own supply projections.

5.13 Use of Recycled Water

Recycled water is becoming increasingly an important supply of water in California as treatment plants have upgraded their treatment processes, recycled water has become more accepted by the public, and water has become scarcer in the State. Unlike other sources of water, the availability of recycled water is fairly stable through drought and wet periods – thus, it is considered to be the most reliable source of water. There are more-strict State requirements for use of recycled water than for other water sources. The requirements become increasingly complex as the recycled water is used in situations where there may be contact with drinking water supplies or edible crops. Irrigation of landscape plants is the least restrictive use. The irrigation of food crops generally requires more advanced treatment, with many produce buyers now requiring a source water audit and regular testing of any type of applied water and of the produce itself.

When the recycled water is used for direct recharge of drinking-water aquifers either through surface spreading basins or injection wells, both the State Department of Public Health and the Regional Water Quality Control Boards are involved in permitting of facilities. One of the important permitting issues is whether there is sufficient travel time of the recharged water between the point of recharge and nearby drinking-water wells (the anaerobic conditions in the aquifer kill pathogens) as an additional safety factor in using the recycled water.

The GWD has planned for water recycling since at least 1980. In 1995, the GWD developed a water recycling project in cooperation with the Goleta Sanitary District. The recycled water project is currently delivering approximately 1,000 acre-feet per year to the University of California Santa Barbara campus, several golf courses, and other irrigation users, most of whom were previously using the GWD potable water for irrigation. The GWD anticipates that recycled water use will increase in future years (GWD, 2008). It was recognized that recycled water has the greatest long-term delivery reliability of any water source because the amount of wastewater flowing into the Goleta Sanitary District even in severe drought conditions far exceeds current recycled water demand.

The least expensive and most accepted use of recycled water is for direct delivery to irrigation users. Recycled water is also used for recharge of groundwater basins, particularly in southern California. However, the increased cost of the advanced treatment necessary for permitting of such facilities precludes its use except when other sources of water have been fully utilized. Consideration of aquifer recharge using recycle water is not recommended at this time for the Goleta basin, especially when expansion of direct use for irrigation is possible.

5.14 Water Balance

A water balance for the basin is an accounting of the inputs and outputs of water to the basin. Examples of inputs to the basin include recharge from percolation of rainfall, percolation from streams, percolation of applied irrigation water, subsurface flow from adjoining bedrock areas and groundwater basins, artificial recharge, and subsurface inflow of salt water from the ocean. Outputs include pumping, subsurface outflow to adjoining basins and/or the ocean, discharge to streams or lakes (when groundwater is at ground surface), and evapotranspiration (when groundwater is near ground surface). The yield of a groundwater basin is the amount of pumping that can occur without creating conditions where outflow exceeds inflow to an extent that undesirable effects occur in the basin. Thus, a water balance can be used to approximate the amount of water that can be safely pumped (i.e., yield of the basin). The yield of a basin can change as inputs and outputs change with time, so it is important to regularly revisit the water balance.

Some of the components of a water balance can be measured, whereas many others can only be approximated. An approximate water balance was constructed to determine the water rights in the basin under the Wright Judgment. In addition, a water balance was required to construct the groundwater model (although some of the inputs and outputs are calculated internally by the model when it is calibrated). It is recommended that the components of the water balance be categorized using measured and model results, with the objective being to determine the various components with more accuracy and fine-tuning the yield of the basin determined during the Wright litigation.

5.15 Groundwater Modeling

The Goleta Groundwater Basin groundwater model was to evaluate potential locations for new wells (see section 5.10-*Shifting of Pumping Locations*) and effects of drought pumping. The model is currently being reviewed by GWD. For future use of the model, it is recommended that procedures be put in place for model maintenance and modeling runs. The procedures should include who would be responsible for maintaining and operating the model (in-house or consultant), whether other organizations could use the model, and how would it be modified in the future when additional information is known about the basin.

5.16 Tracking Contamination Threats

As discussed in section 3.1.2-*Current Groundwater Quality*, there are number of sites of soil and shallow groundwater contamination in the basin. Although most of the sites overlie areas of the aquifers under confining conditions and the contamination is unlikely to leak into the underlying aquifers, it is recommended to review the contamination sites annually. This can easily be done on the State Water Resources Control Board's GeoTracker website. Of particular interest would be sites near drinking-water wells. If a contamination site is identified near one of these wells, it is recommended to make contact with the Regional Board and express an interest in following developments in the cleanup operation. If a site is found in the unconfined portion of the aquifer (near the foothills) and contaminants have been found within groundwater, there should be immediate contact with the Regional Board and cleanup proposals be reviewed with the Board to ensure that the contamination doesn't spread in the aquifer.

5.17 Update of Plan

Regularly-scheduled updates to this Groundwater Management Plan are both prudent and required for State funding of groundwater grants. Other plans that are required by the State (e.g., Urban Water Management Plan) have a five-year update schedule, so it is recommended that this Groundwater Management Plan also have a five-year update schedule. Updates should include current groundwater level and groundwater quality data, groundwater pumping data, groundwater storage data, and any modifications to groundwater operating plans. Updating the Plan should be much less effort than the initial writing of the Plan. The updates should be adopted by GWD and La Cumbre.

5.18 Changes in Rules and Regulations

The interaction of the SAFE Ordinance with Wright Judgment storage rules appears to allow complementary use of these storage programs. If, however, there is a conflict in the future use this stored water, the SAFE Ordinance may need to be modified. This would require a vote of the public in an election.

5.19 Tasks and Timeline

The following items were proposed in this Plan as future tasks:

Section: ***Semi-Annual Monitoring of Groundwater Elevations***

Change months for groundwater elevation monitoring – The proposed change in the date of spring measurements is already being implemented.

Ensure nearby wells are not pumping during groundwater elevation monitoring – This procedure is currently being discussed with the U.S. Geological Survey.

Section: ***Additional Monitoring Points***

Add monitoring wells in the basin – This recommendation should be implemented over the next several years. It is recommended that the wells be installed using grant funding, with a focus on AB 303 funding.

Section: *Monitoring of Water Quality*

Download DPH data every two years – This recommendation should be implemented starting in 2011 and every two years thereafter.

Additional water quality monitoring – The choice of which additional existing wells to monitor should be made prior to 2011, with data collection in 2011 and every two years thereafter. Two or three wells should be chosen from the list provided in section 7.2 *Appendix B – Additional Water Quality Wells.*

Section: *Determination of 1972 Conditions for SAFE Ordinance*

Calculate Well Index – Calculate well index every year following acquisition of spring water levels.

Section: *Confirm Basin Hydrogeology*

Devise long-term plan – Devise a long-term plan to better understand the basin hydrogeology. This long-term plan should be completed prior to the next update of the Groundwater Management Plan.

Section: *Shift of Pumping Locations*

Determine site for two or three new wells – Following the analysis using the groundwater model, plan for next well sites. Planning should be accomplished before the next Plan update.

Section: *Basin Operating Group*

Implement Basin Operating Group – Within one year of adoption of this Plan, implement first group meeting.

Section: *Water Balance*

Better-define water balance – This task is ongoing, with improvements being incorporated from modeling experience.

Section: *Groundwater Modeling*

Determine procedures and operation – Procedures should be put in place for future model maintenance and modeling runs. This planning should be completed within two years of adoption of this Plan.

Section: *Tracking Contamination Threats*

Review contamination sites – Review GeoTracker contamination data once a year.

Section: *Update of Plan*

Update Plan regularly – Update this Plan every five years.

Section: Changes *in Rules and Regulations*

SAFE Ordinance drought trigger – If the GWD's Water Supply Management Plan determines that it would be prudent to add additional triggers for use of the Drought Buffer (e.g., shortage of State Water), review whether GWD should attempt to modify the Ordinance.

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7 Appendices

7.1 *Appendix A – Determination of 1972 Index Wells for SAFE Ordinance*

A total of 14 wells were available in the Central subbasin which had monthly water level measurements in 1972 and are currently being monitored. The geographic distribution of these wells is shown in Figure 7-1. Groundwater elevations for these wells were used to construct a historical record for groundwater elevations in June of each year (Figure 7-2). The annual value shown on the graph was calculated by averaging the groundwater elevations for that June in each of the wells. Gaps appear in the historical record when at least one of the wells had no reported measurements of groundwater levels in that year.

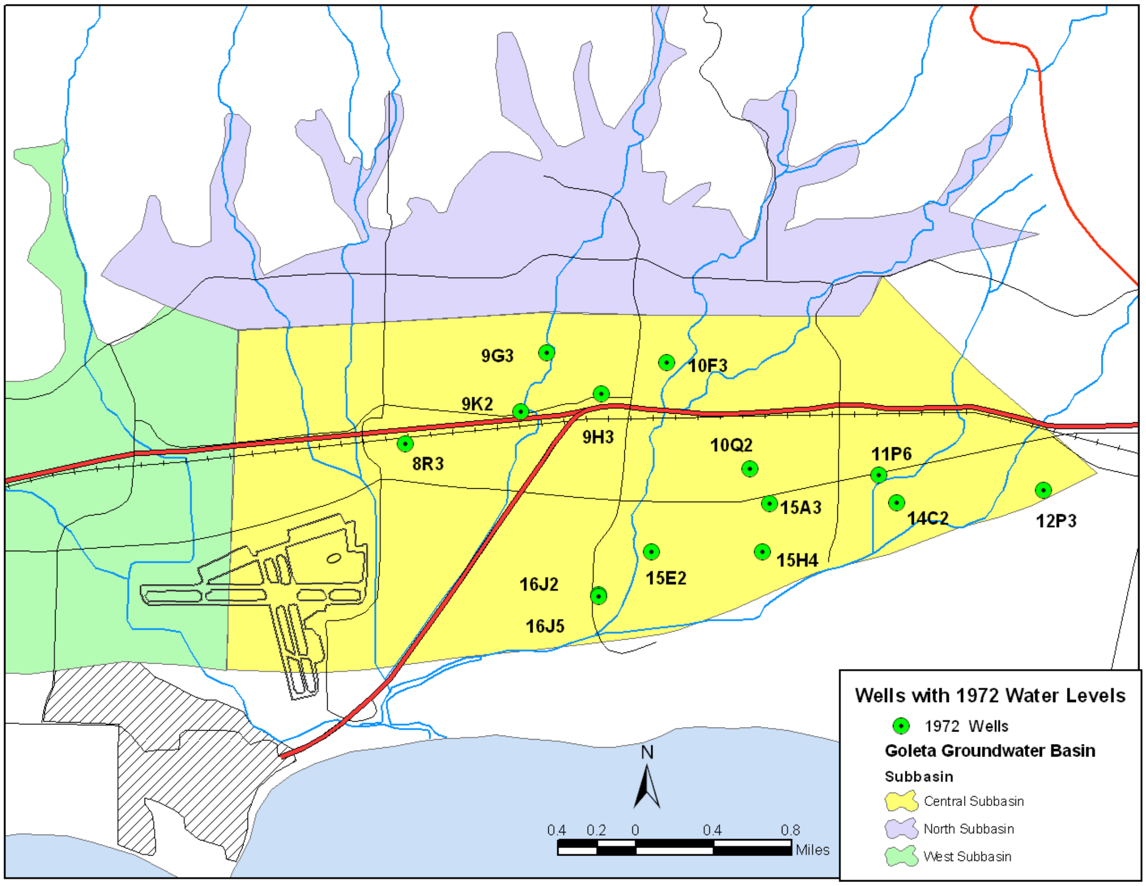

Figure 7-1. Map of wells for which there were monthly groundwater elevation measurements in 1972 and for which there is current monitoring.

To determine what the average looked like in the years where there was at least one missing water level measurement, the average curve was extended by reconstructing data in the missing years. To approximate a missing groundwater elevation measurement in a particular well, groundwater elevations in that well and nearby wells with no missing measurements were cross-correlated for the periods when there were measurements in both wells. A least squares linear analysis of the data was then performed, with a trend line calculated. If the R^2 (coefficient of determination, a value of one being the most reliable line fit) of the line fit was higher than 0.8 (e.g., Figure 7-3), then the resulting formula from the line fit was used to calculate the June groundwater elevation in the unmeasured well. This technique filled out the missing data and allowed average groundwater elevations to be calculated for each year (Figure 7-4). Figure 7-4 indicates that the low groundwater elevation between 1972 and 2008 occurred in 1989, during the drought of the late 1980s and early 1990s.

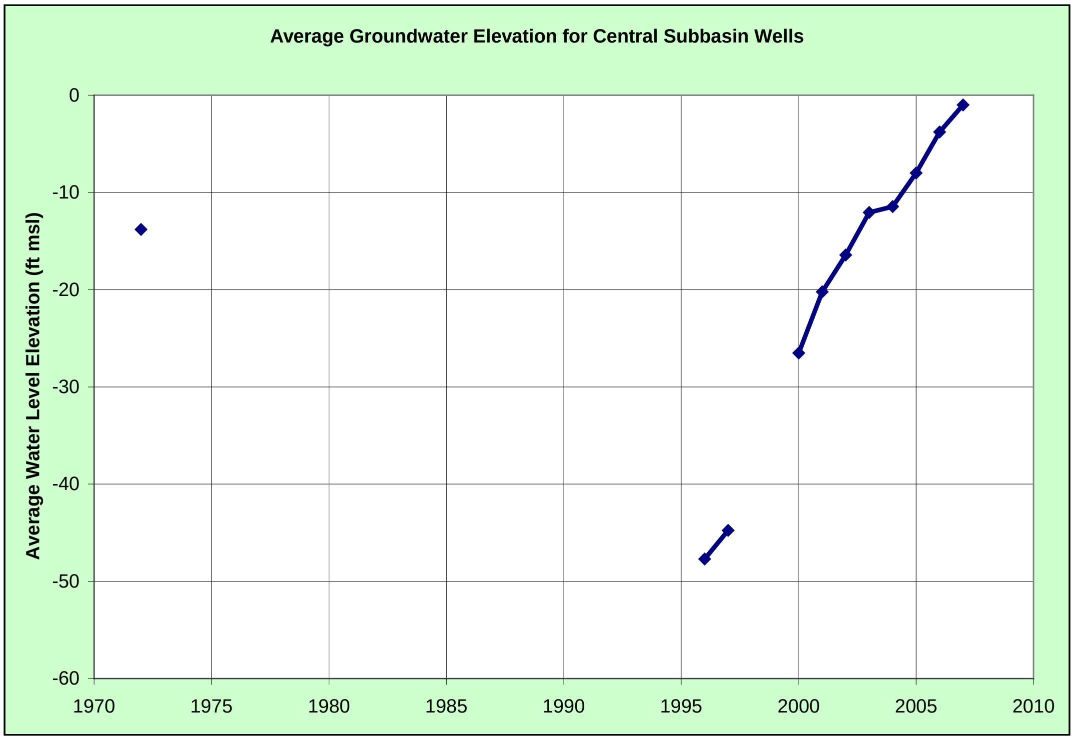

Figure 7-2. Average June groundwater elevations from all wells for which there were monthly groundwater elevation measurements in 1972 and for which there is current monitoring. In years for which no groundwater elevations are shown, at least one of the 14 wells did not have measurements in that year.

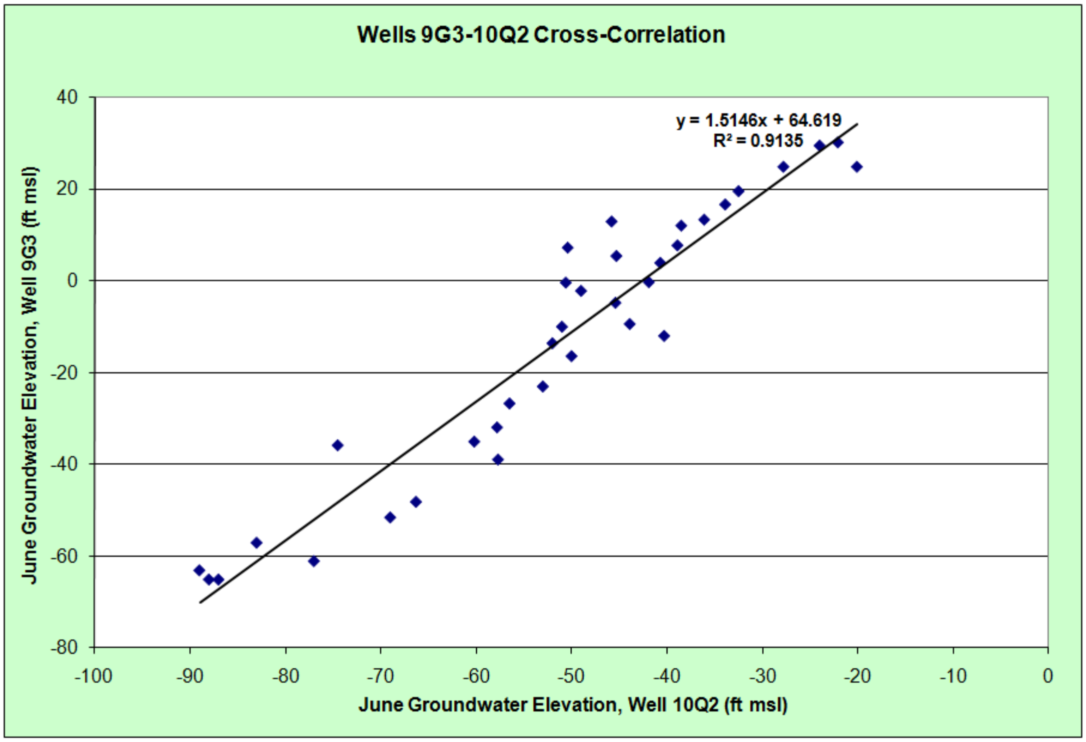

Figure 7-3. Method used to cross-correlate water level measurements between two 1972 wells. Each data point represents a single year – the June groundwater elevations from wells 10Q2 and 9G3 are plotted using the x axis and y axis, respectively. The line represents the best least-squares fit of the data points. The correlation factor (R2) and the equation for the correlation line are also shown. The equation is then used to calculate a missing measurement when only one well was measured in June of any year.

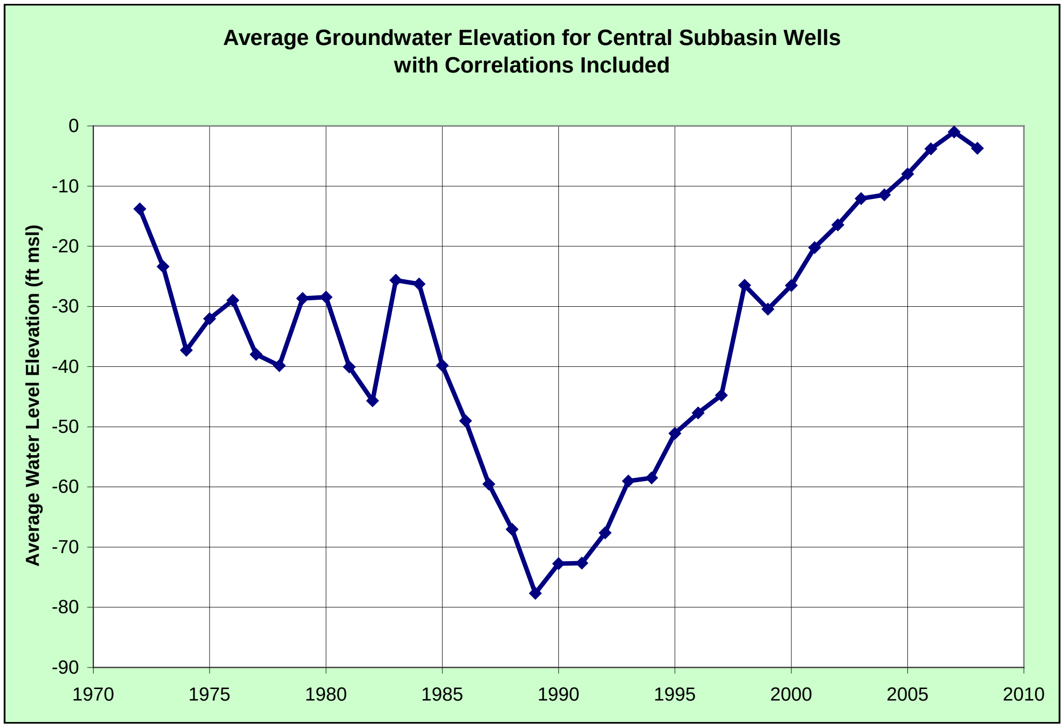

Figure 7-4. Average June groundwater elevations of the 14 wells, with missing data filled in by cross-correlation with nearby wells.

An option for determining where current groundwater elevations are relative to 1972 elevations is to use all 14 wells. The difficulty in doing so is that a significant number of wells need to be cross-correlated, and more importantly, there must be continuous monitoring in the future for all 14 wells for comparison with 1972 levels. Wells do not last forever, so as the 14 wells are destroyed in the future, there must be a replacement well installed that has the same construction (e.g., depth, perforated intervals) as the destroyed well. This may require the purveyors to install a dedicated monitoring well at the site of the destroyed well if the well owner doesn’t replace the well in an identical fashion.

To reduce the number of wells that are averaged to determine 1972 groundwater elevations, a geographic spread of 1972 wells was selected that represent both shallow and deep wells (Figure 7-5). These seven Index Wells require less cross-correlation than using all 14 wells and it will be easier to maintain these well sites in the future. To determine the effect of selecting a sub-group of Index Wells, correlated curves for all 14 wells and for the seven Index Wells are compared in Figure 7-6. The two curves have identical shapes, with the Index Well curve shifted downward by three to ten feet.

Individual wells that make up the 1972 Index are plotted along with the Index Well curve in Figure 7-7 to determine if any one well or one measurement is overly influencing the Index Well curve. All the Index Wells have the same curve shape as the overall Index, even though absolute groundwater elevations vary across the basin, indicating that the Index fairly reflects groundwater elevations in the overall Central subbasin.

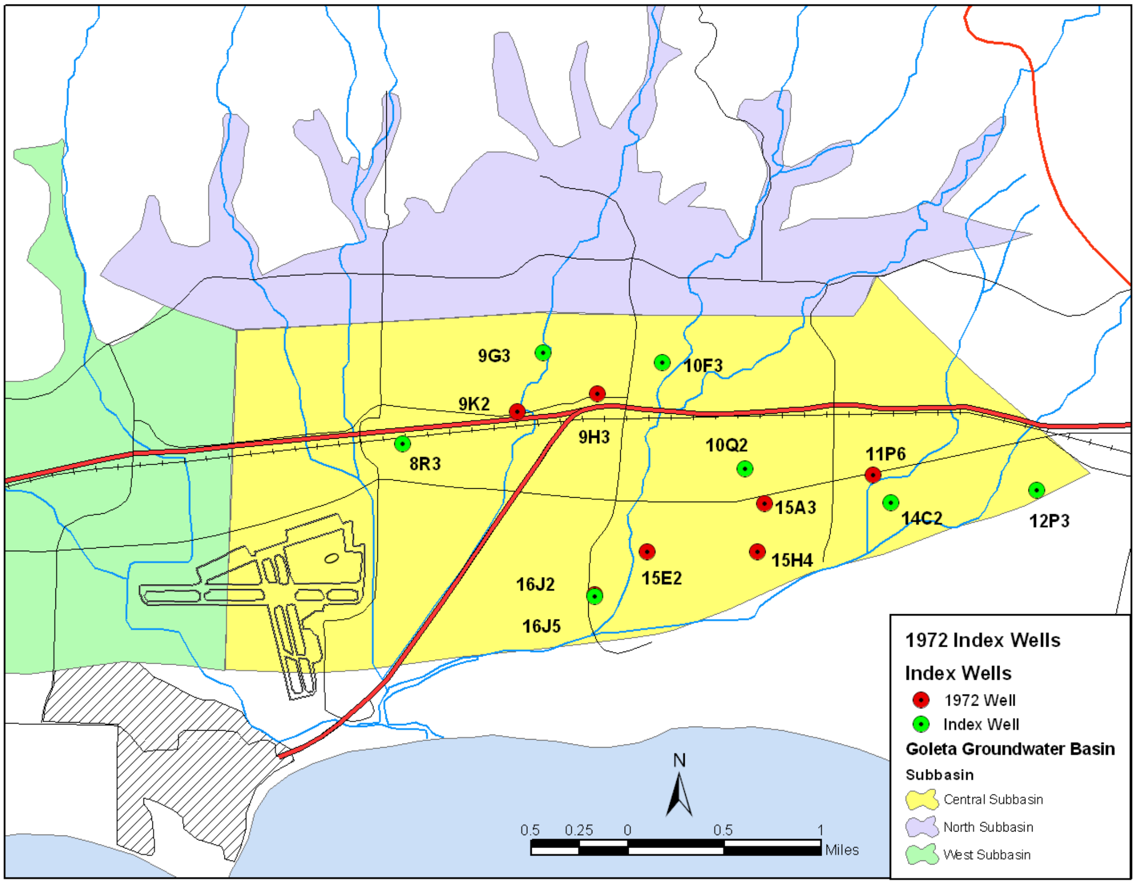

Figure 7-5. Wells selected as Index wells from the larger population of wells that have monthly 1972 water level measurements and are currently monitored.

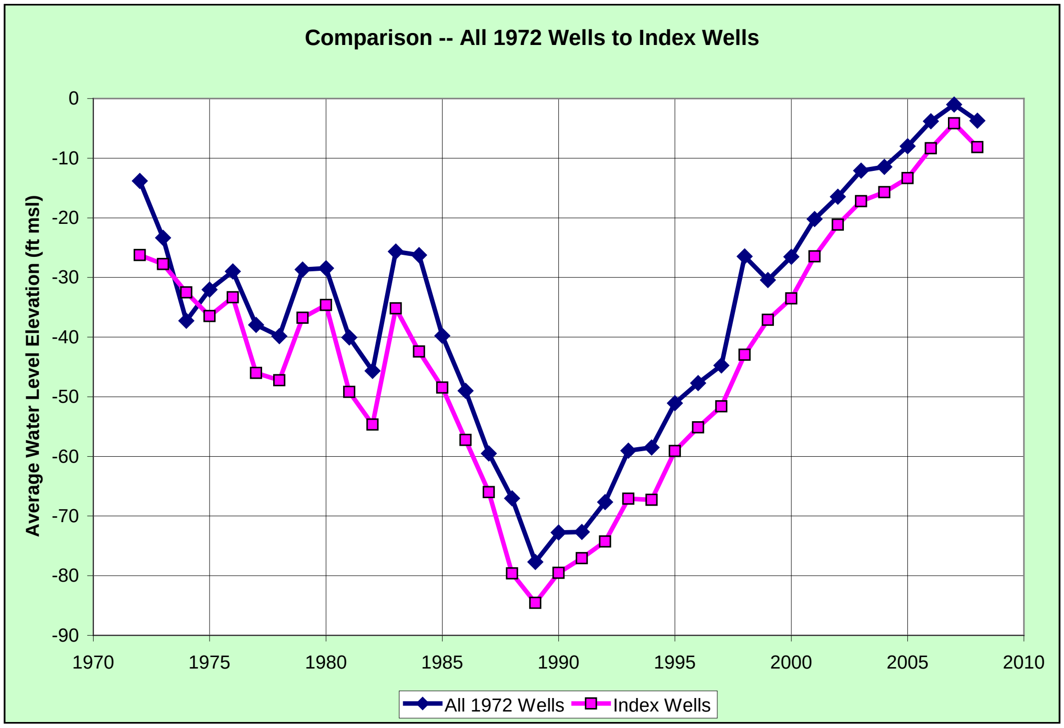

Figure 7-6. Average June groundwater elevations using all 14 of the 1972 wells and using a subset of seven of the wells (Index Wells). The two methods have the same shape of curve, with the Index Well curve shifted downward by a few feet.

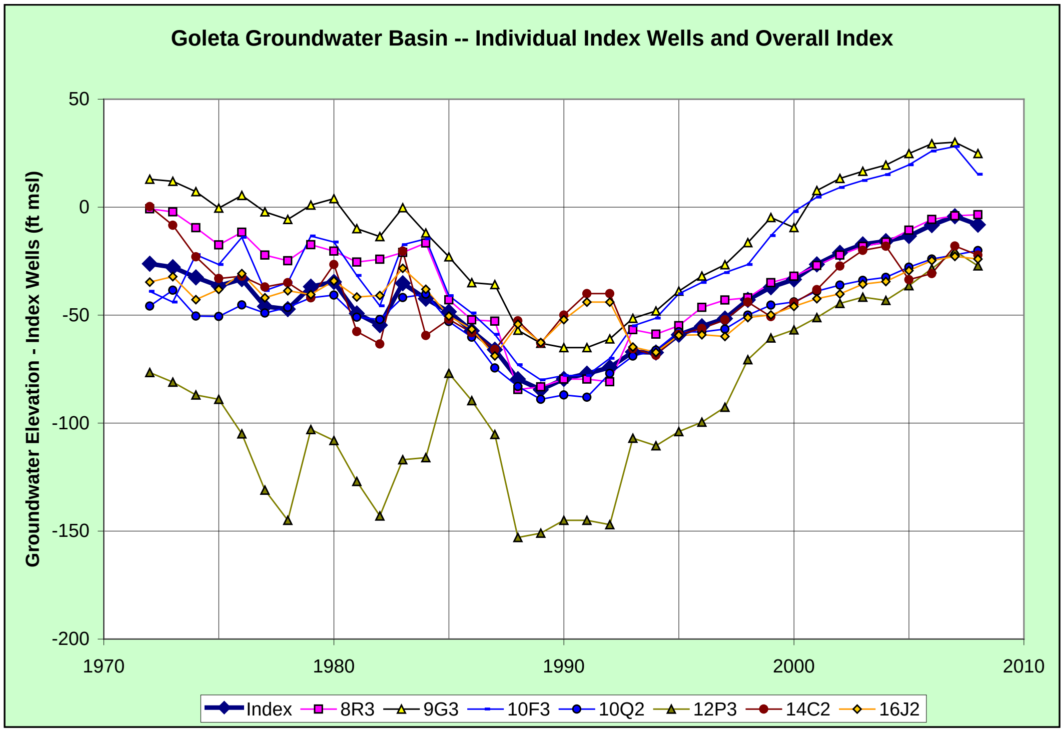

Figure 7-7. Average June groundwater elevations for all seven Index Wells (thick line) and June groundwater elevations for each of the Index wells. Some data points are cross-correlated with nearby wells as discussed in the text. The groundwater elevation curve for individual wells is the same shape as the Index curve, with absolute elevations varying by location in the Central subbasin.

7.2 Appendix B – Additional Groundwater Quality Monitoring

Groundwater quality monitoring is currently conducted by GWD and La Cumbre as part of their California Department of Public Health permit to deliver drinking water. This monitoring constitutes a backbone of the recommended groundwater quality network. This backbone monitoring does leave un-monitored gaps in the basin, especially near the coastal portions of the basin (Figure 7-8).

It is recommended that additional groundwater quality monitoring points be added sequentially both for the BMO wells and a well in the West subbasin (Figure 7-8, Table 7-1). The wells are listed sequentially so that wells can be in stages. An annual general minerals analysis is recommended.

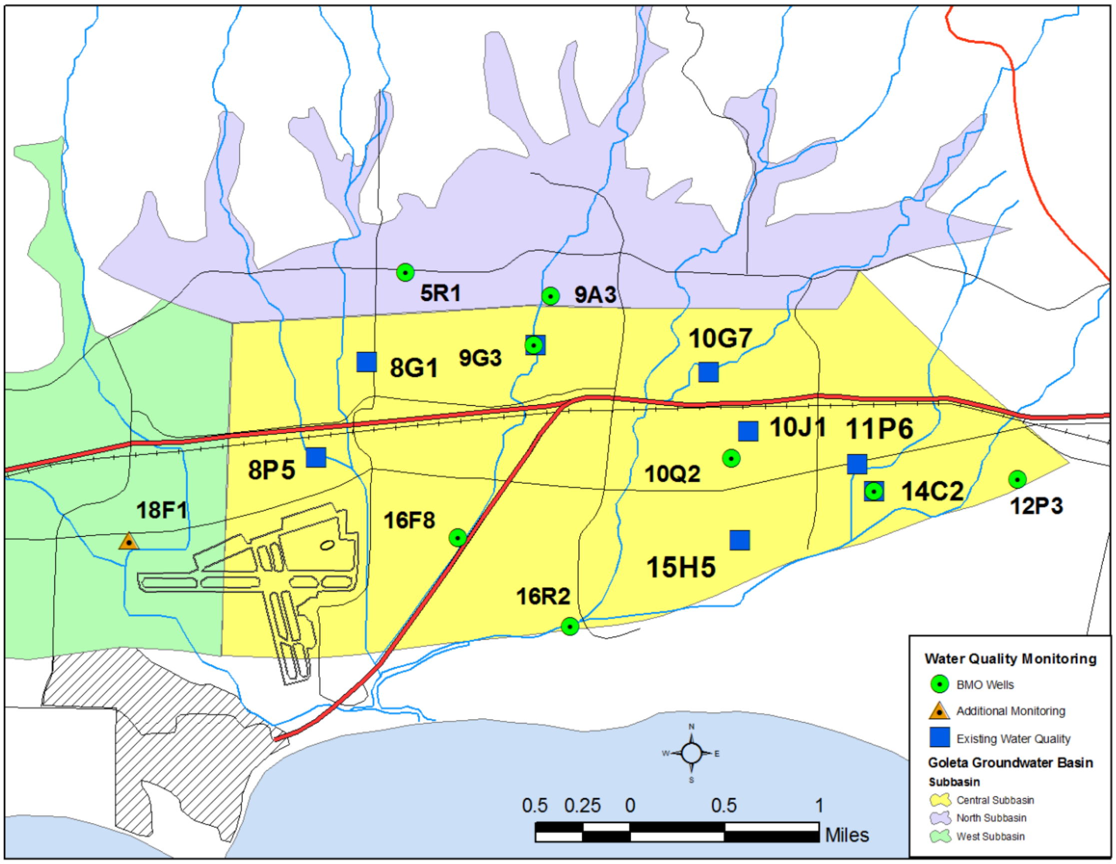

Figure 7-8. Wells where water quality is currently being monitored. BMO wells that are not currently monitored are recommended for inclusion in the water quality monitoring program, as is a well in the West subbasin.

State Well Number	*Name*	*Frequency*	*Analyses*
4N/28W-12P3	La Cumbre #7	DPH[15]	DPH
4N/28W-16R2	More Mesa #1	Annual	General Min
4N/28W-16F8	Mission #1	Annual	General Min
4N/28W-18F1	Bishop #4	Annual	General Min
4N/28W-5R1	Martini	Annual	General Min
4N/28W-9A3	Mulligan	Annual	General Min
4N/28W-10Q2	Emmons	Annual	General Min

Table 7-1. Recommendations for additional water quality sampling in the Goleta basin. The wells are listed in priority order from top to bottom, so that the wells can be added in stages.

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[15] This drinking water well is currently monitored for water quality under requirements of California Department of Public Health – the results of the monitoring should be included in the future in the water quality database for the basin.

Goleta Water District

BOARD OF DIRECTORS

William Rosen – President

Jack Cunningham – Vice-President

Bert Bertrando – Director

Lauren Hanson – Director

Larry Mills – Director

John McInnes – General Manager

Regular Meeting Minutes

Action Summary

Tuesday, May 11, 2010

5:30 P.M.

Goleta Water District Headquarters
Board Room
4699 Hollister Avenue, Goleta, CA 93110

Agendas, Supplemental Materials and Minutes of the Goleta Water District Board of Directors meetings are available on the internet at www.goletawater.com

5:30 p.m. ……………..Convened to Regular Session

Roll call – President Rosen; Vice President Cunningham; Director Bertrando; Director Hanson; Director Mills.

ALSO PRESENT WERE: John McInnes, General Manager; George Eowan, Assistant General Manager; Mike Kanno, Operations Manager; Greg Paul, Water Treatment Superintendent; Matt vanderLinden, Civil Engineer; Carrie Bennett, Engineering Technician; Becky Cantrell, Acting Administrative Manager; Fran Farina, General Counsel; Beth Horn, Assistant Board Secretary; Dr. Steven Bachman; Kate Rees, Manager of Cachuma Operation & Maintenance Board (COMB) and the Cachuma Conservation Release Board (CCRB); Susan Basham, Counsel with Price, Postel & Parma; Eva Turenchalk, Director Goleta Sanitary District.

CONSENT AGENDA

CA-1) MINUTES OF THE BOARD OF DIRECTORS APRIL 13, 2010 AND APRIL 22, 2010 MEETING

CA-2) GENERAL COUNSEL'S MONTHLY REPORT

CA-3) GOLETA WATER DISTRICT'S MONTHLY INTERIM FINANCIAL STATEMENTS

CA-4) GOLETA WATER DISTRICT'S MONTHLY ACCOUNTS RECEIVABLE SUMMARY REPORT

CA-5) GOLETA WATER DISTRICT'S MONTHLY CASH DISBURSEMENT REPORT

CA-6) GOLETA WATER DISTRICT'S MONTHLY INVESTMENT REPORT

CA-7) LAIF AUTHORIZED SIGNATURES

The Board did not take any action on the consent agenda items and the items will be considered by the Board at an adjourned meeting on May 13th.

PUBLIC INPUT: Speakers on this item were Jack Ruskey, Roberta Weissglass, Jeff Hanson and Michael Petretta.

5) APPEAL BY SANTA BARBARA WILDLIFE NETWORK

Ms. Bennett presented a report on the Santa Barbara Wildlife Care Network appeal as allowed under Chapter 8.30 of the Goleta Water District Code concerning the release of 100% of the associated Letter of Credit in advance of the required 1-year warranty period.

Joann St. John, Capital Campaign Chair of the Santa Barbara Wildlife Care Network, gave a presentation regarding their organization's appeal process.

Speaker on this item was Jim Marino.

A motion was made by President Rosen, seconded by Director Bertrando, to approve the appeal by Santa Barbara Wildlife Network subject to the applicant signing an agreement that in the event of a failure, they would be fully liable to pay for a repair or if the District does the repair work, the applicant would pay the District. The motion failed by the following roll call vote:

Ayes:	2 – Directors Bertrando, Rosen
Nay:	3 - Directors Cunningham, Hanson, Mills

6) GROUNDWATER MANAGEMENT PLAN

Dr. Steven Bachman presented a report on the final 2010 Groundwater Management Plan.

a) A motion was made by Director Bertrando, seconded by Director Hanson, to adopt and approve the final 2010 Groundwater Management Plan. The motion carried by the following vote:

Ayes: 5 – Directors Bertrando, Cunningham, Hanson, Mills, Rosen

b) A motion was made by Director Bertrando, seconded by Director Hanson, to approve amendment No. 1 to the Agreement for consulting services with Dr. Steve Bachman to increase the not to exceed contract amount by $4,500 and authorize the Assistant General Manager to execute the Amendment. The motion carried by the following vote:

Ayes: 5 – Directors Bertrando, Cunningham, Hanson, Mills, Rosen

7) SCADA

a) Mr. Paul and Mr. Kanno presented a report on the District's System control and Data Acquisition (SCADA) System.

b) A motion was made by Director Bertrando, seconded by Director Hanson, to accept the report and authorize the General Manager to execute the agreement as modified with Tesco Controls,

19) GENERAL MANAGER'S MONTHLY REPORT

Received a report from Mr. McInnes for April, 2010.

20) FUTURE MEETING AGENDA ITEMS

This item will be considered by the Board at an adjourned meeting on May 13th.

8:56 p.m.....................Meeting adjourned.

DATED: 6/9/10

MINUTES PREPARED BY:

Beth Horn

BETH HORN, ASSISTANT BOARD SECRETARY

DATE APPROVED: 6/8/10

ATTEST:

Beth Horn

BETH HORN, ASSISTANT BOARD SECRETARY

WILLIAM C. ROSEN, PRESIDENT