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May 30, 2014 (Revised February 19, 2015)
Project No. 04.B3033006.11

Carpinteria Valley Water District
Post Office Box 578
Carpinteria, California 93014

Attention: Mr. Charles Hamilton, General Manager

Subject: Carpinteria Groundwater Basin, Annual Report for 2013

Dear Mr. Hamilton:

This annual report presents a summary and description of groundwater conditions in the Carpinteria groundwater basin for calendar year 2013. This represents the 11th annual report that has been prepared to assist the Carpinteria Valley Water District (District) in its ongoing efforts (pursuant to its AB3030 Groundwater Management Plan) to manage the groundwater resources of the basin and provide information on water level and water quality conditions to all users of groundwater in the basin. The intent of the annual report is to provide a brief narrative and graphics that document the "health" of the basin's groundwater resources, trends in groundwater levels and water quality, information on land use, and annual groundwater pumpage. Information on the development of the program, selection of wells to be sampled and surface water sampling points, etc., is available in prior reports prepared for the District.

Four large maps form an integral part of this report. Plate 1 - Water Level Hydrograph Map, April 2013, depicts wells in the basin used for purposes of water level measurements and to assess changes in groundwater in storage. This map shows the physical limits of the groundwater basin, locations of several key wells, historical variations in water levels, and water level contours during the period of April 2013. Plate 2 - Water Level Hydrograph Map, October 2013 depicts water level contours during October 2013. Plates 3 and 4 depict the approximate location of wells that are used to monitor water quality in the basin. These two maps depict trends of several important water quality constituents for groundwater and surface water that are routinely obtained as part of the semiannual water quality data collection program. The data provide information on the concentration and spatial distribution of total dissolved solids (TDS), nitrate, and chloride. These maps are updated annually and are included in each annual report.

PRECIPITATION

Groundwater recharge occurs by direct infiltration of precipitation, streambed percolation, irrigation return flow, and to a limited extent, by underflow from the "hill and mountain" area. Precipitation in the Carpinteria area for the 2013 calendar water year was recorded at a scant 5.7 inches at the Carpinteria Fire Station, which was 70 percent below the long-term average. Precipitation data at the Carpinteria Fire Station have been collected continually since 1949, since when the average annual precipitation has been 19.6 inches.

A graph showing the cumulative departure from average precipitation is presented as Figure 1. The departure from average precipitation is the difference between precipitation in a specific year and the average precipitation for the period. Figure 1 depicts the sum of these departures over time (cumulative). The cumulative departure curve depicts periods of subsequent wet and dry periods by combining annual deviations from average conditions, thereby "stacking" the change from subsequent years. Based on the cumulative departure from average precipitation at this station, there have been a series of cyclic wet and dry periods. Within the period of record, extended dry periods have occurred between 1949 and 1961 (13 years) and again between 1984 and 1990 (seven years). The current dry cycle has now lasted from 1999 to 2013 (15 years). A summary of the hydrologic cycles is summarized as Table 1 – Summary of Precipitation Data. During the 1949 to 1961 dry period, the cumulative departure from average annual rainfall declined by over 40 inches. During the dry period of 1984 to 1990, total rainfall declined by 37 inches. During the current dry period of 1999 to 2013, the total rainfall has declined by 38 inches.

Table 1. Summary of Precipitation Data

Time Period, Calendar Years	Hydrologic Condition	Duration, Years	Cumulative Departure, Inches	Inches Decline or Rise/Year
1949 – 1961	Dry	13	-45	-3.4
1962 – 1977	Alternating Wet and Dry	16	7	0.5
1978 – 1983	Wet	6	38	6.4
1984 – 1990	Dry	7	-37	-5.3
1991 –1998	Wet	8	66	8.3
1999 – 2013	Dry	15	-38	-2.5
2009 – 2013 WY*	Dry	5	-19	-3.8

Note: * 2009–2013 time period included for comparison to recent Carpinteria Groundwater Basin Hydrologic Budget Update, which is based on water years whereas this report is based on calendar years.

Groundwater Levels

Water level measurements were made by District staff on a bimonthly basis for approximately 31 wells in the basin during 2013. The locations of these wells are shown on Plates 1 and 2. The water level data were obtained from District staff and hydrographs prepared for 18 key wells, which are shown on Plates 1 and 2. The data from approximately 28 wells were then used to prepare water level elevation contours, which are shown on Plate 1 for the April 2013 period and on Plate 2 for the October 2013 period. The contours are representative of water levels within wells perforated in several depth zones. Therefore, the contours represent a composite of many different depth zones, not water level conditions in a single, common aquifer. As is usual, several wells included in the water-level measurement program or nearby wells were being pumped and the water levels in surrounding wells were influenced by pumping wells at the time of the water level measurements.

During April 2013, the time period presented on Plate 1, an apparent pumping depression was present in the central portion of the basin generally in the vicinity of the District office. The pumping trough was as deep as about 8 to 10 feet below sea level in the central portion of the groundwater basin associated with groundwater pumpage at the time of the April 2013 measurement period. At that time, the groundwater level at the coast was between a level slightly below sea level, as measured in shallow Well -30D1 (2.1 feet below sea level) and above sea level by 7.3 feet as measured in Well -23A2. Water levels throughout the District fell during the second half of calendar year 2013 in response to below average rainfall.

During October 2013, the time period presented on Plate 2, the apparent pumping depression in the central part of the District continued to be evident to a greater degree than during April 2013 due to seasonal groundwater pumpage, as is common during the fall. During the October water level measurements, the pumping trough was as deep as 10 to 14 feet below sea level in the central portion of the basin. At that time, water levels at the coast lowered to a level between 4 feet below sea level in shallow Well -30D1 and above sea level by 5 feet as measured in Well -23A2 in the far western portion of the basin. The only other well included in the groundwater level measurement program in the general area of the coast is Well -19M3, which is located 2,700 feet inland from the coast and is very shallow (56 feet) where, during October 2013, the groundwater was 4.2 feet below sea level. At a location 1,400 feet further inland from Well -19M3, at Well -19F4, groundwater levels remained above sea levels throughout 2013.

As in previous years, which have exhibited similar water level declines near the coast, there is no documented evidence of sea water intrusion in the basin.

Water level data from the 20-year period including the years 1994 to 2013 indicate that water levels are commonly higher in the winter and spring due to recharge from precipitation and seasonal reduction in groundwater pumpage, and relatively lower in summer and fall due to pumping of groundwater from wells within the District. In general, the hydrographs presented on Plates 1 and 2 illustrate that during the 7-year period of 2006 through 2013, water levels in Storage Unit No. 1 have locally declined by as much as 15 to 25 feet, and in the far eastern portion of the District, groundwater levels have declined by as much as 40 feet. Average annual groundwater pumping in the basin over the five year period between 2009 and 2013 was about 3,655 acre-feet per year (afy). During 2013, due to below average precipitation and moderate groundwater pumpage in the range of 3,400 afy (refer to Figure 2), water levels in the central part of Storage Unit No. 1 have locally declined or risen by as much as 6 feet (refer to Plates 1 and 2) relative to 2012.

Although there are a limited number of wells monitored in Storage Unit No. 2, available data indicated water levels appear to have declined by less than 10 feet in the past three years. This limited decline in groundwater levels is likely due to the limited amounts of groundwater pumped from this storage unit.

Groundwater Use

Groundwater pumpage in the basin occurs both from District production wells (see Plates 1 and 2) and from about 100 private wells. Pumpage from District wells is metered. The District supplies imported water andocal groundwater to numerous agricultural parcels of known acreage and crop type (lemon, avocado, greenhouse, flower fields). From these metered deliveries, unit water use values for various crop types are used to estimate private groundwater pumpage. For calendar year 2013, unit water values were assigned to land uses based on 2012 land use imagery. Based on these calculations, a private pumpage estimate of 3,060 acre-feet was calculated. Summaries of District groundwater pumpage and imported water amounts for 2013 are included in Appendix A - Supporting Data "Public Water System Statistics".

Groundwater pumpage from the basin by the District in calendar year 2013 was 312 acre-feet. Water purchased and imported into the District in calendar year 2013 was 4,513 acre-feet. The volume of groundwater pumpage by the District was approximately 32 percent of the 20-year District average of about 978 afy. Groundwater pumpage in the District between calendar years 1994 and 2013 is presented in Figure 2 - Water Use and Precipitation Data, Carpinteria Valley, and in Table 2 - Water Use and Precipitation Data. Imported water volumes (Casitas MWD, State Project Water, and Lake Cachuma water) and seasonal precipitation totals are also provided in Appendix A. As indicated, groundwater pumpage from the basin between 1994 and 2013 has averaged about 3,553 afy, and ranged from as low as 2,484 afy during 2001, to as high as 4,088 afy during 2012. Although the District typically pumps about one-quarter to one-third of the total groundwater pumped, the District pumpage during 2013 amounted to only 9 percent of the total pumpage.

Table 2. Water Use and Precipitation Data

Calendar Year	Rainfall (inches)	Estimated Private Pumpage (acre-feet)	Metered CVWD Pumpage (acre-feet)	Imported Water (acre-feet)	Total Pumpage (acre-feet)	District Use (percent)
1994	15.02	2,780	1,305	3,206	4,085	32
1995	41.35	2,418	1,340	2,995	3,758	36
1996	25.86	2,597	1,410	2,896	4,007	35
1997	19.98	2,504	1,242	3,429	3,746	33
1998	41.35	2,481	469	3,549	2,950	16
1999	8.91	2,400 [1]	535	3,907	2,935	18
2000	18.99	2,400 [1]	1,210	2,959	3,610	34
2001	24.23	2,400 [1]	84	3,497	2,484	3
2002	12.28	3,116	662	3,774	3,778	18
2003	14.62	2,596	446	3,769	3,042	15
2004	19.42	2,698	1,265	3,884	3,963	32
2005	27.20	2,183	940	3,693	3,123	30
2006	16.86	2,270	1,142	3,147	3,412	33
2007	9.67	2,606	1,340	2,684	3,946	34
2008	19.22	2,865	1,074	2,842	3,939	27
2009	14.39	2,596	1,488	2,835	4,084	36
2010	26.30	2,294	742	3,157	3,036	24
2011	14.56	2,428	1,365	2,673	3,793	36
2012	12.43	2,896	1,192	3,356	4,088	29
2013	5.73	3,060	312	4,513	3,372	9
Mean	19.42	2,575	978	3,338	3,553	27
Maximum	41.35	3,116	1,488	4,513	4,088	36
Minimum	5.73	2,183	84	2,673	2,484	3

Notes: 1) 1999 to 2001 private pumpage estimated based on long-term average.

The estimates of the safe yield for the groundwater basin have been reassessed several times during the past 30 years. Most recently in 2012 Pueblo Water Resources, Inc. completed a modeling study of the District's groundwater basin and arrived at a revised "practical rate of withdrawal," or "operational yield" of the basin of 3,600 to 4,200 afy based on long-term hydrologic conditions. Prior to the most recent estimate, a value of 4,500 to 5,000 afy was considered the "safe yield" of the basin, (GTC, 1976 and 1986). In 2003, the District retained the firm of Integrated Water Resources, Inc. to perform an independent review of this value. The results of that study reasserted that a basin "safe yield" in the range of 4,500 to 5,000 afy was appropriate. Since that time, the District has discontinued reference to "safe yield" but has instead referred to an "operational yield," which is understood as a range of long term average annual pumpage at which no undesirable effects will occur.

The total groundwater pumpage has not exceeded the prior "safe yield" range of 4,500 to 5,000 afy, nor the upper limit of the current "operational yield" of 4,200 afy during the most recent 20 year period. Further, the average pumpage of 3,553 afy is below the lower bound of the current "operational yield" of 3,600 afy.

During 2014, a hydrologic budget for the groundwater basin, originally developed as part of the creation of a groundwater flow model, was updated for the period of water years 2009 through 2013. The hydrologic budget update indicated that during the most-recent 5-year period between water years 2009 and 2013, the groundwater basin experienced a net average annual storage depletion of 618 acre-feet per year. Notably, the data presented during this period, which occurs during a dry hydrologic condition, generally supports the trends of groundwater pumpage and precipitation presented in this report, although that report is based on a water year basis (Tables 1, 2 and Figure 2). The memo report is included in the appendix.

GROUNDWATER QUALITY

Groundwater quality in the Carpinteria basin is monitored by collecting samples from as many as 30 wells and 6 surface water stations on a biannual basis (spring/fall). The data collection program was initiated by the District in early 1999. Laboratory analyses performed included a full range of inorganic chemical constituents typically referred to as "Irrigation Suitability Analysis."

Groundwater quality in the basin continues to be suitable for most uses. As shown on Plates 3 and 4, TDS concentrations for most wells range from 600 to 1,000 milligrams per liter (mg/l).

Of interest, nitrate concentrations (as nitrate) within Well -19MI have been elevated in past years with concentrations of over 400 mg/l in 2005. Since then, nitrate concentrations have declined to as low as 68 mg/l and were approximately 240 mg/l in both samples collected during 2013. By contrast, nitrate concentrations within Well -19E1 were much lower, with a maximum concentration of 22 mg/l during 2013. Nitrate concentrations within Well -28F7 (Lyons Well) have been rising for the past several decades to a value of 39 mg/l in 2013 (expressed as nitrate).

During 2013, chloride concentrations within Well -19MI and adjacent Well -19E1 have been above 350 mg/l. Chloride concentrations in well -19MI have remained relatively steady and elevated for the past several years with a recent up-tick to 364 mg/l during the fall of 2013. Well -19M1 is 204 feet deep and likely has very shallow perforations although the actual depth interval is unknown. Well -19E1 is located approximately 900 feet north and is a relatively shallow well. As in past years, comparison of water quality data from the two wells shows that, although chloride concentrations are higher than many monitored wells, neither nitrate nor TDS in Well -19E1 are as elevated as those in Well -19M1.

Chloride concentrations within Well -30D1, located near the coast and originally completed to a depth of 210 feet, have been rising since 2008 from a concentration of less than 30 mg/l until 2011, since when concentrations have moderated to below 80 mg/l. Neither nitrate nor TDS concentrations have been elevated in Well -30D1 during this time since 2008 relative to wells located in the central portion of the basin. Because the depths of the perforated interval in the well are not known, and because it has been noted that the measured total depth of the well is much shallower than 210 feet, this well is not considered an appropriate "sentinel" well for early warning of seawater intrusion.

Groundwater in the basin is generally characterized as calcium bicarbonate in chemical nature and locally demerited by the presence of elevated nitrate and chloride concentrations in shallow aquifers in Sections 19 and 20 of the basin. Other than the locally high nitrate concentrations in Section 19 and 20, and slightly elevated chloride concentrations in Well -30D1, which have moderated since 2011, the groundwater quality appears stable with no long-term trends toward impairment.

SUMMARY AND CONCLUSIONS

Based on the data for 2013 and the preceding years, aquifers in the Carpinteria basin continue to be adequately recharged during average to above average precipitation years, and provide a generally high quality of groundwater for the prevailing usages. During the spring and fall of 2013 water levels in the central part of Storage Unit No. 1 continued to remain at elevations moderately below sea level. Groundwater pumpage from the basin in 2013 was estimated to be approximately 3,372 afy, which does not exceed the lower bound of the "operational yield" estimate of 3,600 afy. During 2013, pumpage has moderated compared to 2012, which with continued below-average rainfall, caused water levels in the central portion of the basin to rise modestly compared to the previous year. At the coast, water levels have not changed significantly during 2013 relative to 2012. No adverse water quality conditions or trends are apparent in the basin other than the occurrence of elevated nitrate and chloride ion concentrations in two shallow wells in the western portion of the basin.

We recommend that the data collection program (water levels and water quality) be maintained in its current form in the subsequent years with the following modifications:

With the observed depression in water levels in the central part of Storage Unit No. 1 the District may consider expanding the water quality monitoring program to include additional wells and more frequent monitoring (perhaps quarterly) in that area for general mineral constituents, particularly chloride ion concentrations. The expanded monitoring should focus on qualified wells (suitable depth and perforated interval) located in Sections 19, 20, 28, and 29.

In conjunction with this increased monitoring, the installation of several monitoring wells located in key areas where hydrogeologic data are lacking should be considered. These additional monitoring wells should be designed to monitor groundwater levels and groundwater quality and levels in aquifers A though C and be provided with dedicated transducers to collect groundwater water level and electrical conductivity data (such as CTD Divers).

With the continuation of groundwater levels that are slightly below sea level near the coast in the shallow (Well -30D1) and associated possibility of seawater intrusion, the District should consider installation of so-called "sentinel" wells at the coast completed to the depths of the four primary aquifers. The monitoring wells should be provided with dedicated pressure and conductivity transducers to monitor temporal changes in water quality. Data from the sentinel wells could be collected monthly or quarterly and graphs developed to depict any trends in groundwater level and quality (i.e., conductivity measurements as an early indicator of possible seawater intrusion into the basin).

CLOSURE

This report has been prepared for the exclusive use of the Carpinteria Valley Water District and their agents for specific application to the conditions of groundwater supply and quality in the Carpinteria groundwater basin in Carpinteria, California. The findings and conclusions presented herein were prepared in accordance with generally accepted hydrogeologic engineering practices. No other warranty, express or implied, is made.

Sincerely,

FUGRO CONSULTANTS, INC.

Timothy A. Nicely, CHg
Senior Hydrogeologist

Attachments: Figure 1 - Cumulative Departure from Average Precipitation
Figure 2 - Water Use and Precipitation Data
Plate 1 - Water Level Hydrograph Map, April 2013 Period
Plate 2 - Water Level Hydrograph Map, October 2013 Period
Plate 3 - Chemical Hydrograph Map - Western Extent
Plate 4 - Chemical Hydrograph Map - Eastern Extent
Appendix A - Supporting Data

Copies Submitted: (10) Addressee

REFERENCES

Geotechnical Consultants, Inc. (1976), *Hydrogeologic Investigation of the Carpinteria Ground Water Basin,* consultant's unpublished report prepared for the Carpinteria County Water District, June 11.

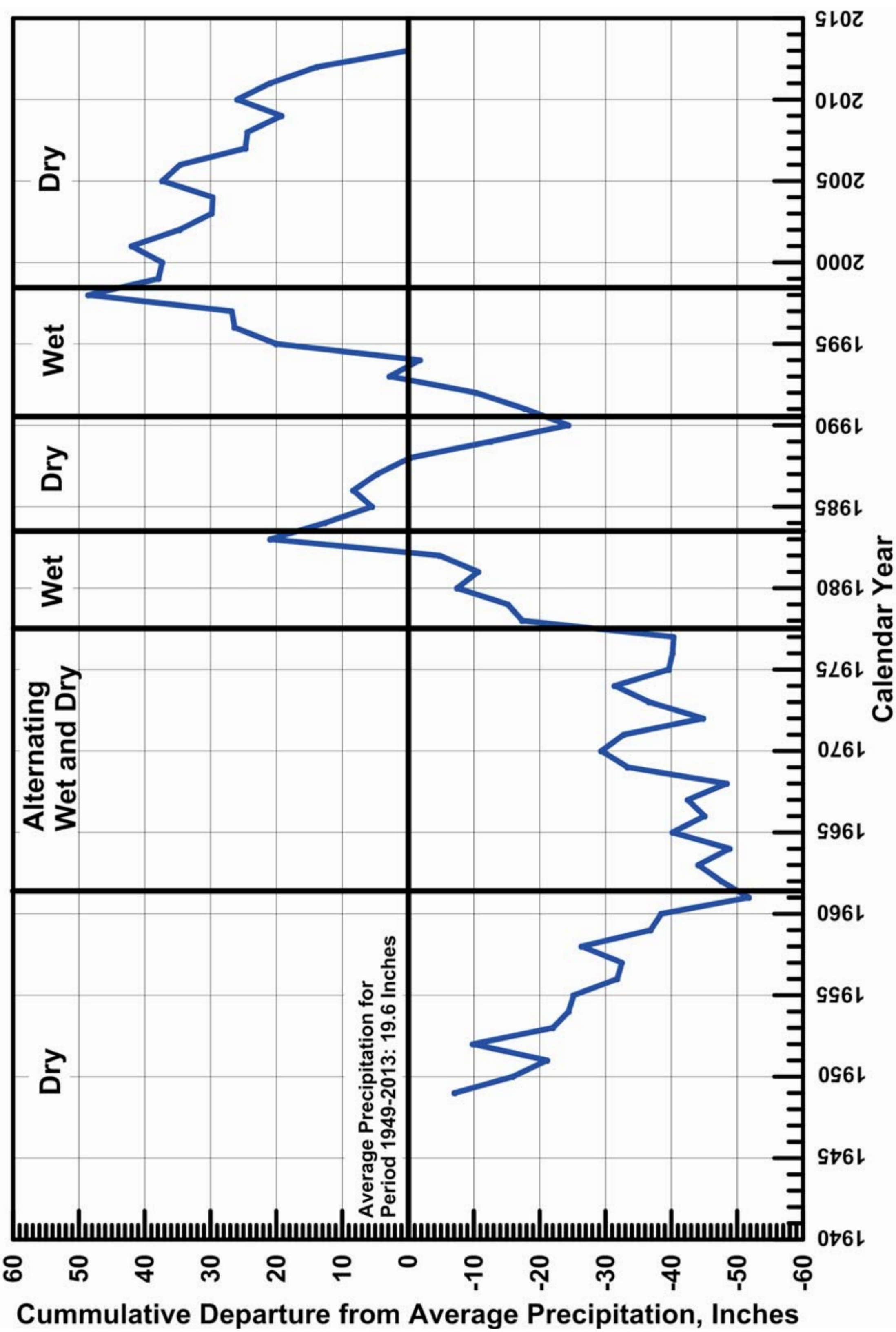
_____ (1986), *Hydrogeologic Update, Carpinteria Groundwater Basin*, consultant's unpublished report prepared for the Carpinteria County Water District, July.

Integrated Water Resources, Inc. (IWR, 2003) *Perennial Yield Review of the Carpinteria Valley Groundwater Basin*, consultant's unpublished report prepared for the Carpinteria County Water District, February 25.

Pueblo Water Resources, Inc. (2012) *Carpinteria Groundwater Basin Hydrogeologic Update and Groundwater Model Project*, consultant's unpublished report prepared for the Carpinteria County Water District, June 30.

Pueblo Water Resources, Inc. (2013) *Carpinteria Groundwater Basin Hydrogeologic Budget Update, Water Years 2009 – 2013,* consultant's unpublished report prepared for the Carpinteria County Water District, April 21.

FIGURES



CUMULATIVE DEPARTURE FROM AVERAGE PRECIPITATION
Carpinteria Fire Station
Carpinteria Valley Water District

FIGURE 1

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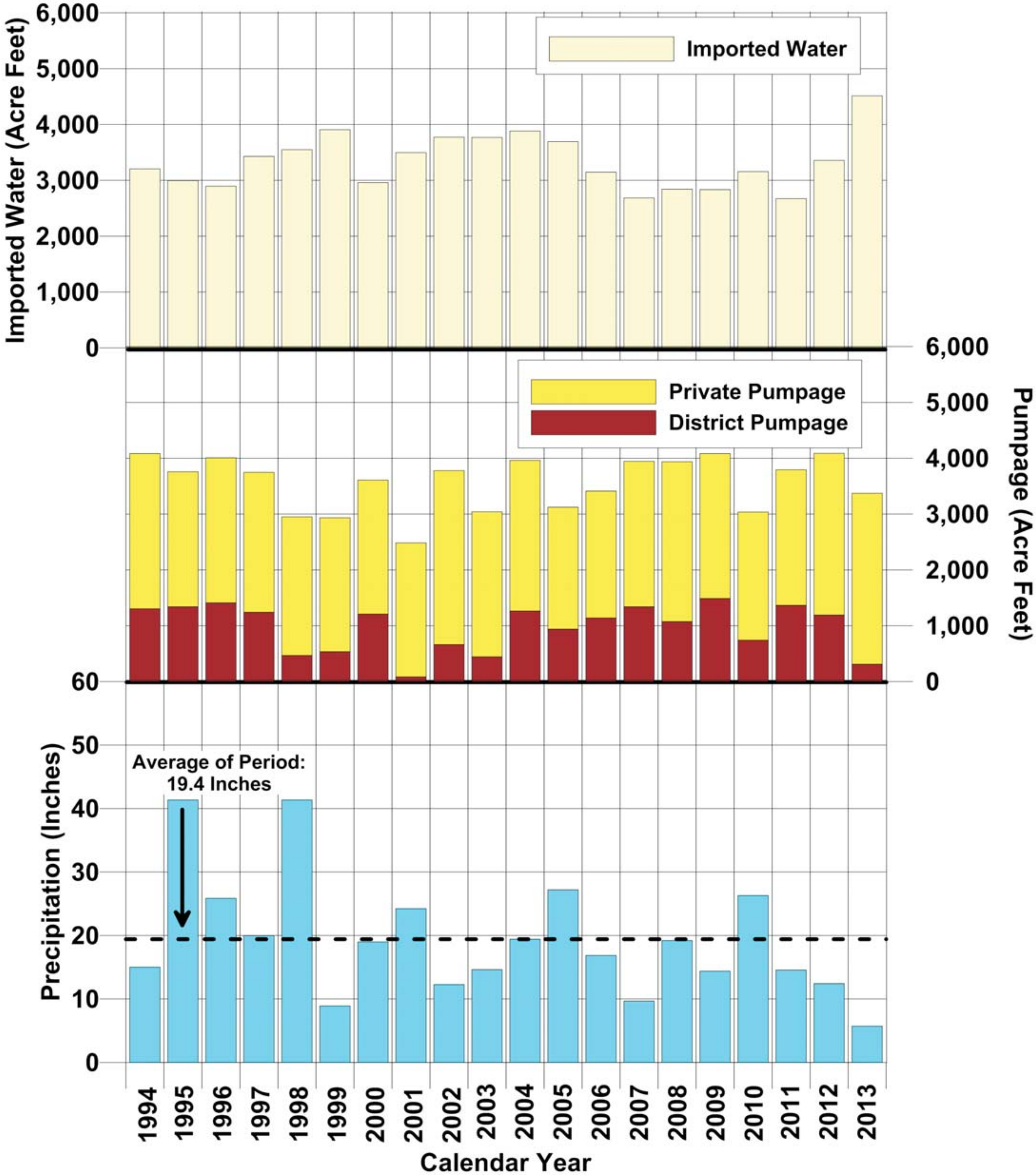

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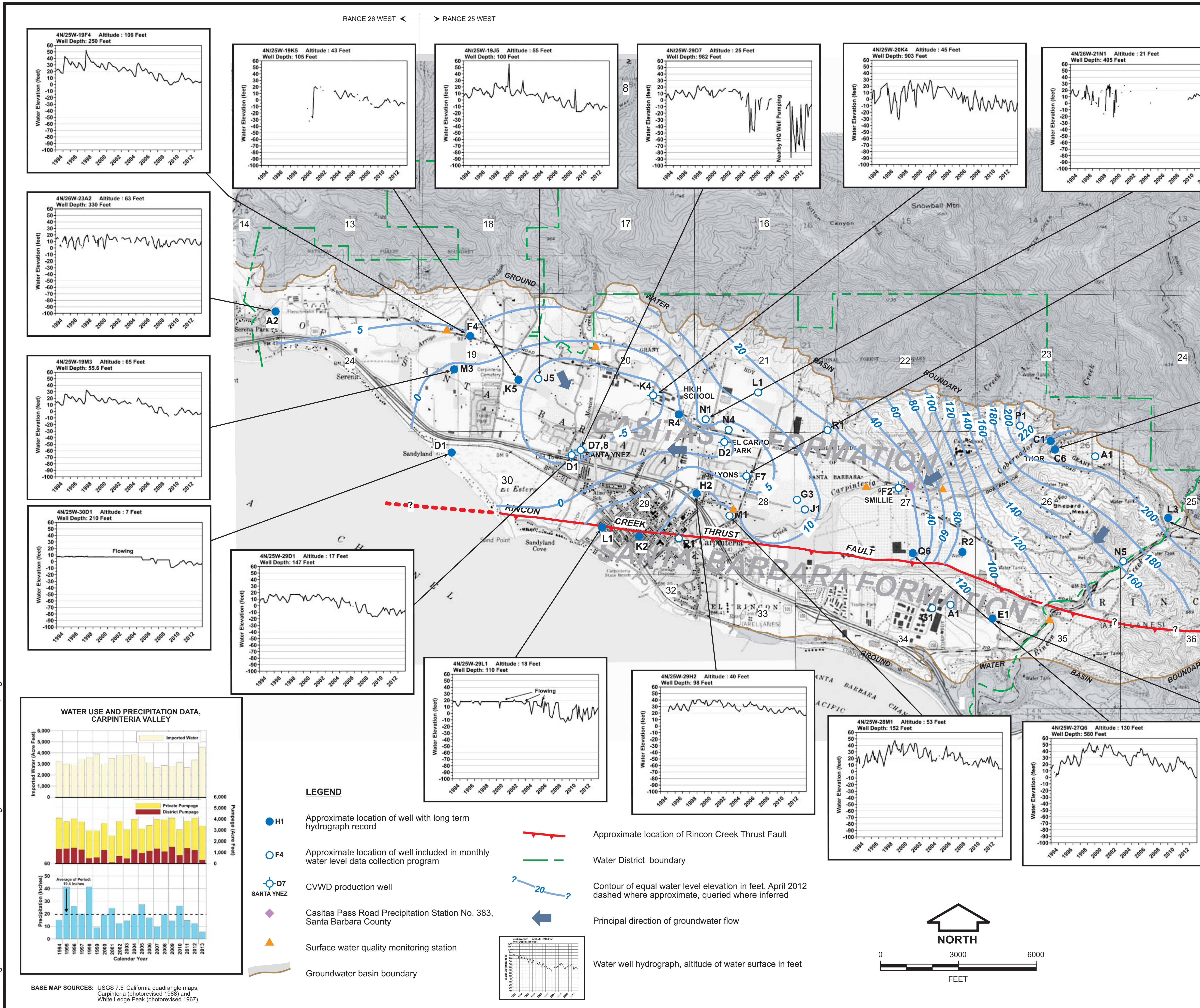
WATER USE AND PRECIPITATION DATA
Carpinteria Valley Water District

FIGURE 2

PLATES



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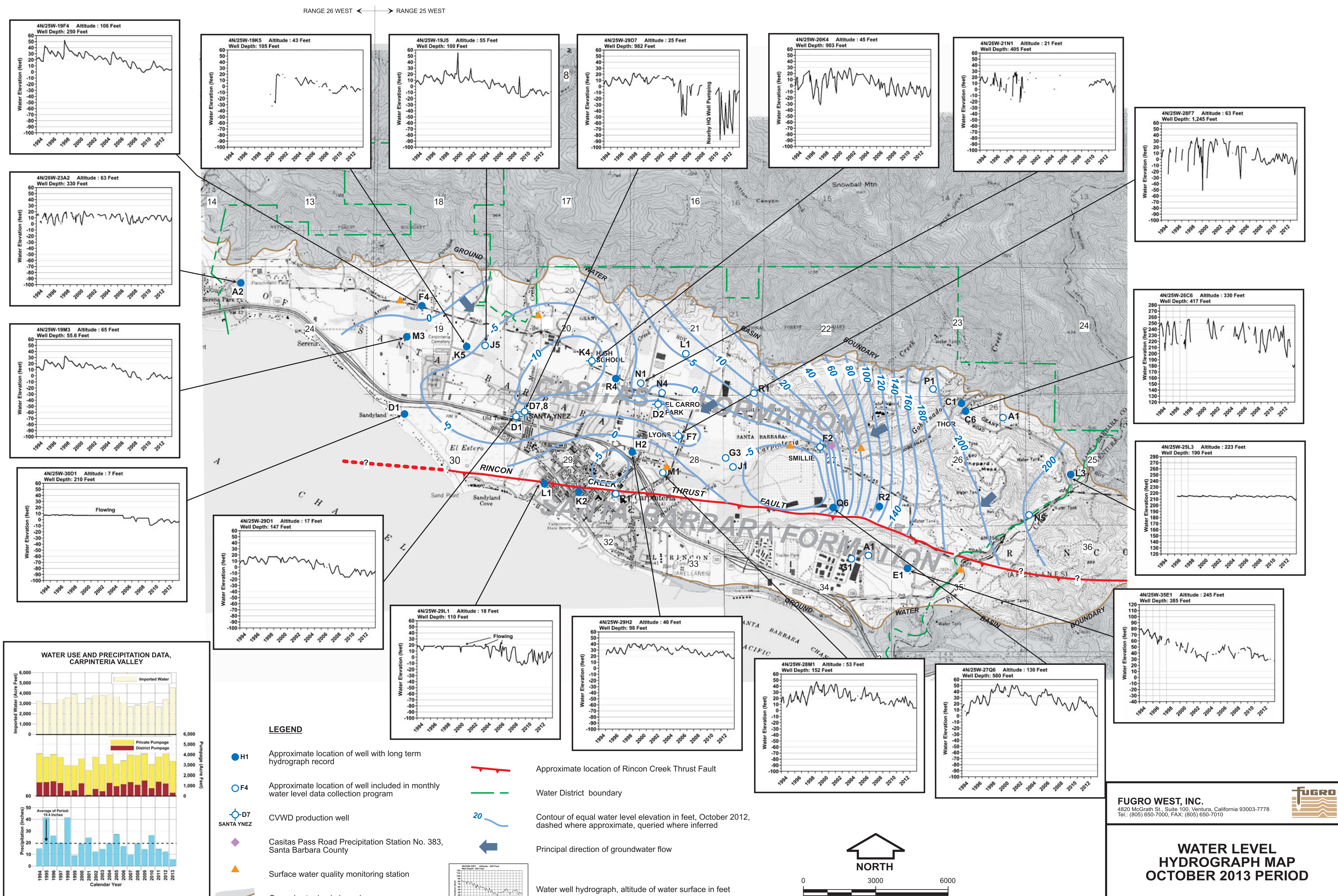
WATER LEVEL HYDROGRAPH MAP APRIL 2013 PERIOD

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.B3033006.11 | April 2014 | PLATE 1



LEGEND

- H1 — Approximate location of well with long term hydrograph record
- F4 — Approximate location of well included in monthly water level data collection program
- D7 SANTA YNEZ — CVWD production well
- Casitas Pass Road Precipitation Station No. 383, Santa Barbara County
- Surface water quality monitoring station
- Groundwater basin boundary
- Approximate location of Rincon Creek Thrust Fault
- Water District boundary
- 20 — Contour of equal water level elevation in feet, October 2012, dashed where approximate, queried where inferred
- Principal direction of groundwater flow
- Water well hydrograph, altitude of water surface in feet

NORTH

0 3000 6000

FEET

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

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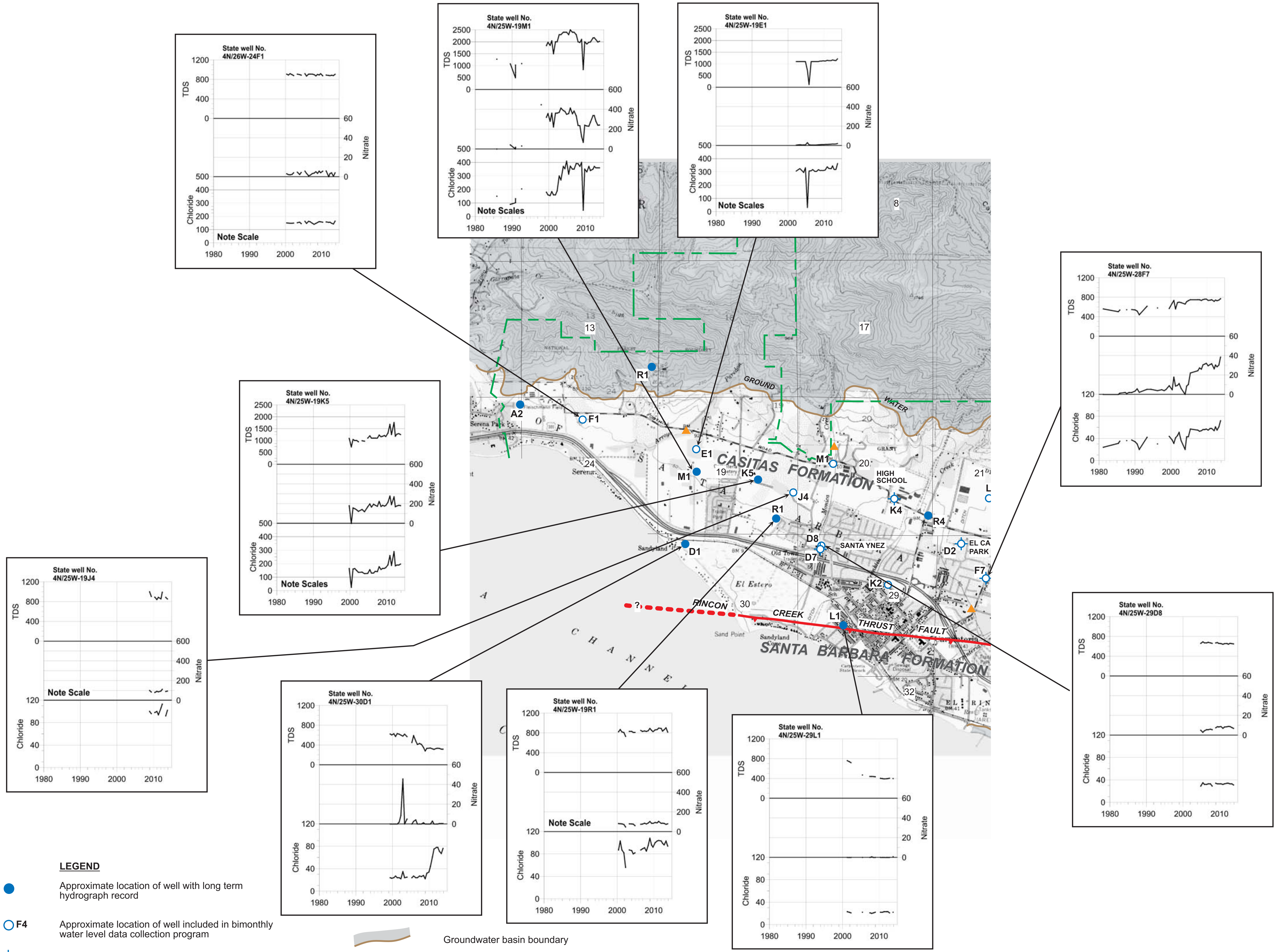
WATER LEVEL HYDROGRAPH MAP OCTOBER 2013 PERIOD

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.B3033006.11

April 2014

PLATE 2



LEGEND

Approximate location of well with long term hydrograph record

F4 Approximate location of well included in bimonthly water level data collection program

D7 CVWD production well

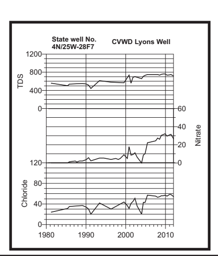
SANTA YNEZ Casitas Pass Road Precipitation Station No. 383, Santa Barbara County

Surface water quality monitoring station

Groundwater basin boundary

Approximate location of Rincon Creek Thrust Fault

Water district boundary



Chemical Hydrograph, all constituents in milligrams per liter (mg/l)

NORTH

0 3000 6000

FEET

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

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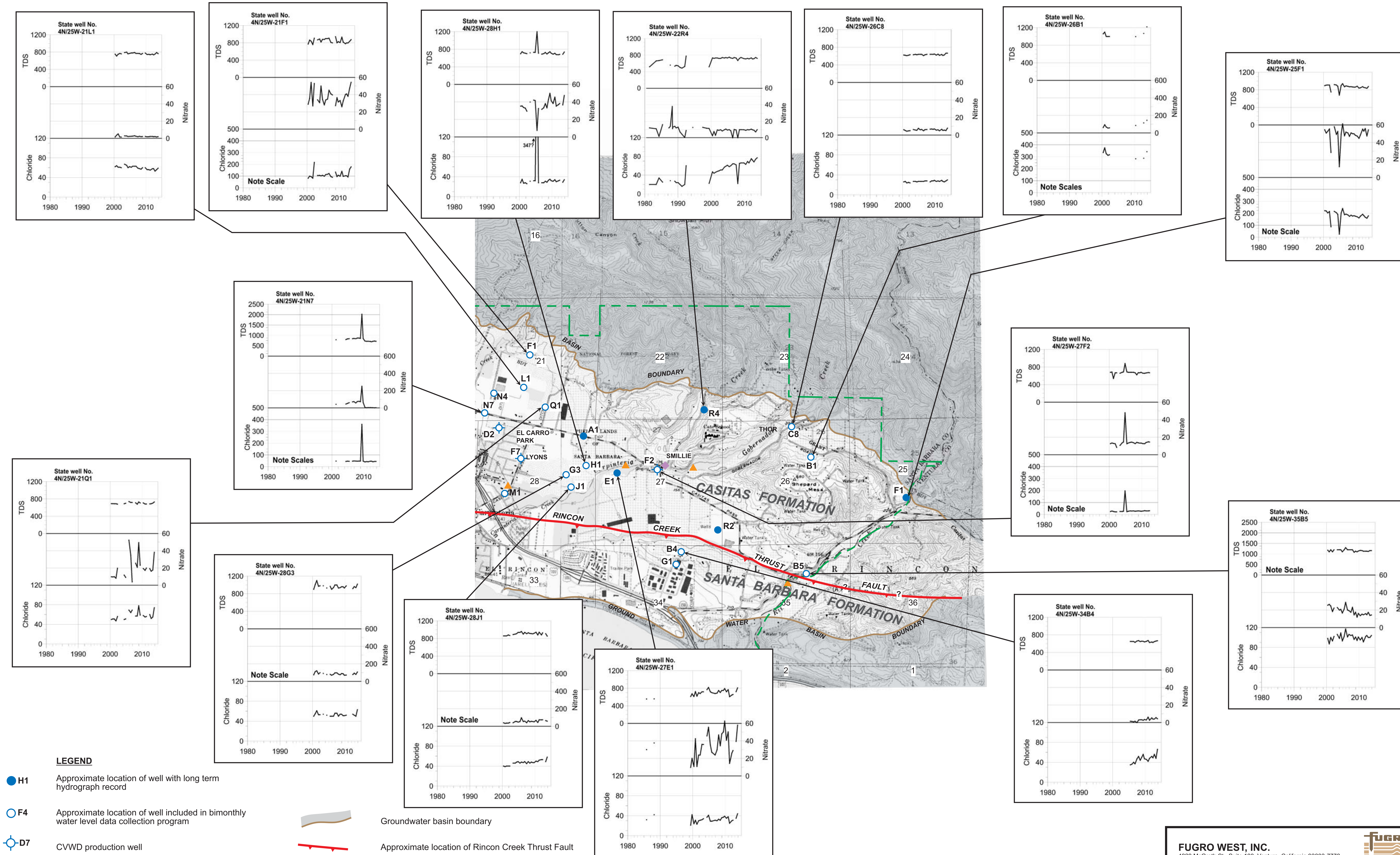
CHEMICAL HYDROGRAPH MAP (WESTERN EXTENT)

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.B3033006.11 | April 2014 | PLATE 3



LEGEND

- H1 — Approximate location of well with long term hydrograph record
- F4 — Approximate location of well included in bimonthly water level data collection program
- D7 — CVWD production well
- SANTA YNEZ — Casitas Pass Road Precipitation Station No. 383, Santa Barbara County
- Surface water quality monitoring station
- Groundwater basin boundary
- Approximate location of Rincon Creek Thrust Fault
- Water district boundary
- Chemical Hydrograph, all constituents in milligrams per liter (mg/l)

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

NORTH

0 3000 6000
FEET

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CHEMICAL HYDROGRAPH MAP (EASTERN EXTENT)

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.B3033006.11 | April 2014 | PLATE 4

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APPENDIX A
SUPPORTING DATA

State of California | DEPARTMENT OF WATER RESOURCES | California Natural Resources Agency

PUBLIC WATER SYSTEM STATISTICS

Calendar Year **2013**

Carpinteria Valley Water District
Robert McDonald, District Engineer
1301 Santa Ynez Avenue
Carpinteria, CA 93013
PWS#4210001 SRO

1. General Information

Please follow the provided instructions.

Contact : Robert McDonald
Title: District Engineer
Phone: 805-684-2816 ext. 107
Fax: 805-456-2148
E-mail: bob@cvwd.net
Website: www.cvwd.net
County: **Santa Barbara**
Population served: **15,141 (estimated)**
Names of communities served: City of Carpinteria & unicorpor

2. Active Service Connections

Customer Class	Potable Water		Recycled Water	
	Metered	Unmetered	Metered	Unmetered
Single Family Residential	3168	0	0	0
Multi-family Residential	349	0	0	0
Commercial/Institutional	277	0	0	0
Industrial	58	0	0	0
Landscape Irrigation	48	0	0	0
Other	125	0	0	0
Agricultural Irrigation	404	0	0	0
TOTAL	4429	0	0	0

3. Total Water Into the System - Units of production: **AF**

(Select: **AF**=acre-feet; **MG**=million gallons; **CCF**=hundred cubic feet)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Potable	*Wells*	74.1	0.0	0.0	0.0	4.9	122.1	11.5	40.3	59.0	0.0	0.0	0.0	311.8837
	Surface	0	0	0	0	0	0	0	0	0	0	0	0	0
	Purchased 1/	129.6	212.0	250.6	450.0	486.0	318.0	552.0	474.4	457.5	475.8	384.5	322.8	4513.16
	Total Potable	203.6942	212	250.6	450	490.8695	440.12	563.48	514.67	516.57	475.75	384.5	322.79	4825.044
Untreated Water		0	0	0	0	0	0	0	0	0	0	0	0	0
Recycled 2/		0	0	0	0	0	0	0	0	0	0	0	0	0

1/ Potable wholesale supplier(s): Cachuma Project & SWP

2/ Recycled wholesale supplier(s):

Level of treatment:

Water deliveried > water produced. Please check your entries

4. Metered Water Deliveries - Units of delivery: **AF**

(Select: **AF**=acre-feet; **MG**=million gallons; **CCF**=hundred cubic feet)

If recycled is included, X box ↓		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
A.SingleFamilyResidential		52.9	60.1	64.0	81.7	85.6	99.9	101.2	109.0	95.5	95.6	78.2	66.1	989.7819
B.Multi-family Residential		34.9	36.7	36.7	44.0	41.9	47.9	47.9	52.3	44.6	44.7	40.4	38.1	510.2984
C.Commercial/Institutional		24.16437	33.60882	37.99357	66.44628	67.3944	73.05785	78.09688	130.2594	110.9642	58.70064	50.26171	31.34527	762.2934
D.Industrial		4.501837	5.982553	5.477502	7.194674	7.421947	7.727273	7.320937	8.748852	7.943067	7.789256	7.066116	5.943526	83.11754
E.Landscape Irrigation		1.650597	2.612489	3.213958	5.259412	6.64371	7.561983	9.22865	9.024334	8.787879	8.126722	6.588613	2.972911	71.67126
F.Other		0.795737	0.123488	0.150103	0.148016	0.086757	0.320567	0.383036	0.216635	0.389278	0.494763	0.338748	0.485249	3.932378
Total Urban Retail *(A thru F)*		118.9867	139.1019	147.5766	204.7302	209.0606	236.4638	244.1434	309.5325	268.213	215.4466	182.8663	144.9733	2421.095
Agricultural Irrigation		83.44123	94.2034	144.1644	203.5032	216.1547	233.7695	243.6846	254.1185	256.4624	238.4435	183.6983	135.4339	2287.078
Wholesale*(to other agencies)*		0	0	0	0	0	400	0	0	0	0	0	0	400

Summary of Water Quality Data, Spring & Fall 2013

Carpinteria Valley Water Distric

Groundwater Basin Data Collection Progran

																		PH		E.C.						
Well No.	Owner/Name	Sample Date	Calcium	Magnesium	Potassium	Sodium	Carbonate	Bicarbonate	Sulfate	Chloride	Nitrate	Fluoride	Boron	Copper	Iron	Manganese	Zinc	Field	Lab	Field	Lab	SAR	TDS	Alkalinity	Hardness	Ammonia Nitrogen
4N/25W-19E1	Ocean Breeze	5/9/2013	131	36	1	209	<10	320	112	318	16.4	1.2	2.2	<0.01	<0.05	0.02	<0.02	7.25	7.3	1801	1800	4.2	1140	270	475	--
		10/28/2013	129	37	1	204	<10	330	128	364	21.6	1.4	2.1	<0.01	<0.05	0.02	<0.02	7.3	7.2	1800	1850	4.1	1220	270	474	--
4N/25W-19J4	Carlton	5/16/2013	145	38	1	50	<10	320	149	92	91	0.2	<0.1	<0.01	0.24	<0.01	0.13	7.22	7	1261	1260	1	886	260	518	--
		11/1/2013	131	37	1	46	<10	290	152	102	94	0.3	0.1	<0.01	<0.05	<0.01	0.09	7.46	7.2	1189	1230	0.9	853	240	479	--
4N/25W-19K5	Westland Floral	5/9/2013	210	63	1	88	<10	380	175	190	184	0.2	0.3	<0.01	<0.05	<0.01	<0.02	7.01	7.1	1775	1790	1.4	1290	310	783	--
		10/30/2013	186	56	1	75	<10	380	169	197	181	0.2	0.2	<0.01	<0.05	<0.01	<0.02	7.4	7	1730	1810	1.2	1250	310	694	--
4N/25W-19M1	Abbott	5/17/2013	304	78	1	188	<10	450	370	360	240	0.6	1.1	<0.01	0.14	<0.01	<0.02	7.12	6.9	2770	2820	2.5	1990	370	1080	--
		11/5/2013	316	80	2	190	<10	450	380	360	242	0.7	1.2	<0.01	0.11	<0.01	<0.02	7.21	7.5	2780	2810	2.5	2020	370	1120	--
4N/25W-19R1	Westland Floral	5/9/2013	159	40	1	55	<10	320	151	103	74.5	0.3	0.1	<0.01	<0.05	0.04	<0.02	7.4	7.4	1220	1250	1	904	260	561	--
		10/31/2013	127	33	<1	44	<10	300	139	94	79.8	0.4	<0.1	<0.01	<0.05	0.05	<0.02	7.61	7.4	1134	1180	0.9	817	240	453	--
4N/25W-20K4	CVWD (High School, Raw)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-20K4	CVWD (High School,Treated)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-20L2	Westland Floral	5/17/2013	67	18	1	105	<10	380	65	54	2.4	0.3	0.2	<0.01	0.11	0.33	<0.02	7.55	7.3	900	898	2.9	693	310	241	--
		11/6/2013	73	19	1	100	<10	380	70	59	1.4	0.3	0.3	<0.01	0.1	0.33	<0.02	7.65	8	907	924	2.7	704	310	260	--
4N/25W-20M1	Ocean Breeze/Foothill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-20Q3	Westland Floral	5/17/2013	72	39	1	73	<10	350	86	59	46.3	0.5	0.1	<0.01	<0.05	0.28	<0.02	7.33	7.1	1007	999	1.7	727	290	340	--
		11/6/2013	80	43	1	75	<10	350	93	65	57.2	0.5	0.1	<0.01	<0.05	0.3	<0.02	7.5	7.5	1020	1030	1.7	765	290	377	--
4N/25W-20R4	Persoon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-21F1	Rancho Antigua	5/13/2013	83	37	1	78	<10	430	26	90	36	0.4	<0.1	<0.01	<0.05	<0.01	0.05	7.41	7.2	1069	1060	1.8	781	350	359	--
		10/28/2013	87	39	1	79	<10	430	31	103	39.3	0.5	0.2	<0.01	<0.05	<0.01	0.03	7.33	7.4	1080	1080	1.8	810	350	378	--
4N/25W-21L1	Bradley	5/8/2013	100	34	2	82	<10	390	124	56	1.7	0.3	0.2	<0.01	<0.05	0.02	<0.02	7.6	7.6	967	984	1.8	790	320	389	--
		10/28/2013	93	32	2	74	<10	380	122	59	2.1	0.3	0.2	<0.01	<0.05	<0.01	<0.02	7.46	7.8	990	988	1.7	764	310	364	--
4N/25W-21N7	Ocean Breeze	5/8/2013	88	31	2	77	<10	370	110	45	1.9	0.3	0.2	<0.01	<0.05	0.02	0.03	7.53	7.5	891	898	1.8	726	310	347	--
		10/28/2013	86	29	2	68	<10	360	119	45	3.3	0.3	0.1	<0.01	<0.05	0.01	0.02	7.8	7.9	909	896	1.6	713	300	334	--
4N/25W-21N4	Brand Flowers	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-21Q1	Overgaag/Westerlay Roses	5/8/2013	85	29	2	77	<10	350	90	55	17.8	0.3	0.1	0.04	0.16	0.6	<0.02	8.4	7.5	867	901	1.8	704	290	331	--
		11/5/2013	90	31	1	71	<10	350	75	74	38.2	0.4	<0.1	<0.01	<0.05	0.35	<0.02	7.5	8	980	992	1.6	731	290	352	--
4N/25W-22R4	Vedder	5/8/2013	113	32	2	58	<10	310	144	74	7.1	0.2	0.1	<0.01	<0.05	<0.01	<0.02	7.35	7.4	975	973	1.2	743	250	414	--
		10/28/2013	107	29	1	50	<10	300	147	77	9.9	0.2	<0.1	<0.01	0.06	<0.01	0.03	7.25	7.5	970	986	1.1	721	240	386	--
4N/25W-25F1	Nichols	5/14/2013	123	42	1	73	<10	290	99	159	47.4	0.3	<0.1	<0.01	0.05	<0.01	<0.02	7.38	7.1	1274	1280	1.4	835	240	480	--
		10/28/2013	123	43	2	69	<10	290	114	179	54.4	0.4	<0.1	<0.01	<0.05	<0.01	0.13	7.4	7.7	1204	1270	1.4	875	240	484	--
4N/25W-26B1	Dautch	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		10/28/2013	194	47	2	98	<10	280	109	342	145	0.2	<0.1	<0.01	0.1	<0.01	<0.02	7.2	7.4	1750	1820	1.6	1220	230	677	--
4N/25W-26C8	Thor	5/8/2013	103	31	2	41	<10	300	155	28	5.3	0.3	<0.1	<0.01	<0.05	<0.01	<0.02	7.65	7.6	823	826	0.9	667	240	385	--
		10/24/2013	100	30	1	37	<10	300	160	30	8	0.3	<0.1	<0.01	<0.05	<0.01	<0.02	8	7.7	800	840	0.8	666	240	373	--
4N/25W-27D1	Westland Floral	5/17/2013	94	30	1	51	<10	310	117	56	14.8	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.5	7.2	925	943	1.2	674	260	358	--
		11/6/2013	102	32	1	52	<10	310	127	63	17.2	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.4	7.7	950	954	1.2	704	250	386	--
4N/25W-27E1	Phelps	5/15/2013	114	31	1	41	<10	330	131	35	39.4	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.61	7.3	965	955	0.9	723	270	412	--
		11/4/2013	132	36	1	42	<10	350	147	44	57.9	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.79	7.8	1054	1070	0.8	810	280	477	--
4N/25W-27F2	CVWD (Smillie well)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-27R2	Shepard Farms	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-28A1	Moore	5/8/2013	94	30	2	63	<10	340	105	45	20	0.3	0.1	<0.01	<0.05	0.03	<0.02	7.55	7.3	843	869	1.4	696	280	358	--
		10/28/2013	89	28	1	55	<10	330	108	49	19.4	0.4	<0.1	<0.01	<0.05	0.05	<0.02	7.7	7.8	885	880	1.3	680	270	337	--
4N/25W-28D2	CVWD (El Carro,Raw)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-28D2	CVWD (El Carro,Treated)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-28F7	CVWD (Lyons)	7/3/2013	115	30	2	57	<10	310	137	61	30.3	0.2	<0.1	<0.01	0.17	0.35	<0.02	8	6.9	949	968	1.2	742	260	410	--
		11/4/2013	115	29	1	50	<10	330	135	72	38.5	0.2	<0.1	<0.01	0.12	0.13	<0.02	7.63	7.4	1022	1200	1.1	771	270	406	--
4N/25W-28G3	Dal Pozzo	5/9/2013	155	42	1	56	<10	390	163	50	80.9	0.2	0.1	<0.01	<0.05	0.02	<0.02	7.4	7.5	1200	1210	1	938	320	560	--
		11/18/2013	155	43	1	53	<10	390	203	63	108	0.2	<0.1	<0.01	<0.05	0.02	<0.02	7.55	7.6	1235	1280	1	1020	320	564	--
4N/25W-28H1	Huff	5/15/2013	102	28	1	45	<10	330	114	29	36.6	0.3	<0.1	<0.01	<0.05	<0.01	<0.02	7.6	7.1	880	906	1	686	270	370	--
		11/4/2013	112	31	1	45	<10	340	125	34	47.3	0.3	<0.1	<0.01	<0.05	<0.01	<0.02	7.44	7.7	931	946	1	736	270	407	--
4N/25W-28J1	Catlin	5/16/2013	145	39	1	49	<10	400	161	49	65.7	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.5	7.1	1150	1200	0.9	910	330	522	--
		11/7/2013	147	40	1	48	<10	310	193	58	59.2	0.2	<0.1	<0.01	<0.05	<0.01	<0.02	7.5	7.9	1170	1180	0.9	856	250	531	--
4N/25W-29D7	Santa Ynez Well (CVWD)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-29D8	H.Q. Well (CVWD Raw)	6/14/2013	86	23	1	61	<10	340	100	31	6.9	0.2	0.1	0.21	0.11	0.09	0.03	7.6	7.6	830	827	1.5	649	280	309	--
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4N/25W-29D8	H.Q. Well (CVWD Finish)	6/14/2013	85	23	1	63	<10	340	101	33	7.8	0.2	0.1	<0.01	<0.05	<0.01	<0.02	7.65	7.7	840	839	1.6	654	280	307	--
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4N/25W-29K2	Pekins	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-29L1	Saragosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		11/4/2013	32	16	3	51	<10	240	32	22	0.7	0.2	<0.1	0.01	0.51	0.02	1.3	8.32	8	519	542	1.8	397	200	146	--
4N/25W-30D1	Sandyland/Slough Well	5/16/2013	16	10	2	61	<10	160	<2	67	<0.4	0.4	<0.1	<0.01	1.4	0.12	<0.02	8.9	8.2	520	503	2.9	316	130	81.1	--
		11/4/2013	16	9	2	61	<10	150	<2	76	0.4	0.4	0.1	<0.01	0.62	0.1	0.04	8.41	8.4	515	536	3	315	130	77	--
4N/25W-34G1	Aluminum Filter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/25W-34B4	Twin Pines	5/9/2013	98	28	2	57	<10	310	110	48	5.7	0.3	0.1	0.07	0.18	0.02	<0.02	7.7	7.7	870	864	1.3	659	260	360	--
		10/24/2013	90	27	2	54	<10	320	103	66	4.4	0.4	0.1	<0.01	<0.05	0.01	<0.02	8.3	7.6	700	878	1.3	667	260	336	--
4N/25W-35B5	Van der Kar	5/13/2013	161	56	2	98	<10	420	310	100	13.9	0.2	0.2	<0.01	<0.05	<0.01	<0.02	8.1	7.6	1515	1530	1.7	1160	340	632	--
		10/28/2013	160	53	2	91	<10	410	330	104	14.5	0.3	0.3	<0.01	<0.05	<0.01	<0.02	7.8	7.9	1464	1410	1.6	1160	330	617	--
4N/25W-35E4	Van der Kar	6/11/2013	140	47	3	146	<10	210	400	147	0.8	0.3	0.2	<0.01	0.55	0.07	<0.02	7.65	7.7	1543	1580	2.7	1090	180	543	--
		10/28/2013	142	47	3	137	<10	220	480	175	1.3	0.3	0.2	<0.01	0.76	0.06	<0.02	7.16	7.5	1611	1610	2.5	1210	180	548	--
4N/26W-13R1	Baker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/26W-23A2	Zangger	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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4N/26W-24F1	Hickey Brothers	5/9/2013	80	36	1	136	<10	450	34	142	<0.4	0.9	0.3	<0.01	0.2	0.12	<0.02	7.4	7.6	1215	1220	3.2	880	370	348	--
		10/28/2013	78	36	1	133	<10	450	40	164	4.1	1.1	0.3	<0.01	0.22	0.10	<0.02	7.43	7.5	1224	1230	3.1	907	370	343	--
Toro Creek		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Arroyo Paredon Creek		5/9/2013	101	32	3	367	<10	450	64	480	<0.4	3.1	4.6	<0.01	<0.05	<0.01	<0.02	8.45	8.4	2350	2340	8.1	1500	360	384	0.1
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Santa Monica Creek		5/9/2013	85	27	<1	46	<10	280	137	22	<0.4	0.3	0.2	<0.01	<0.05	<0.01	<0.02	8.7	8.5	777	764	1.1	597	230	323	<0.1
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Carpinteria Creek		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Gobernador Creek		5/8/2013	103	38	2	55	<10	330	168	35	1.5	0.3	<0.1	<0.01	<0.05	<0.01	<0.02	8.23	8	920	905	1.2	733	270	413	<0.2
		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rincon Creek		5/9/2013	102	49	2	110	<10	430	137	97	6.1	0.5	0.5	<0.01	<0.05	<0.01	<0.02	8.47	8.3	1236	1220	2.2	934	350	456	<0.1
		10/28/2013	95	56	2	119	<10	450	164	147	8.8	0.7	0.5	<0.01	<0.05	<0.01	<0.02	8.6	8.3	1400	1370	2.4	1040	370	467	<0.2

Concentrations in milligrams per liter, except Electrical Conductance (micromhos/cm) and pH.
Non detected concentrations shown as < PQL (Practical Quantitation Limit)
NA = Not Available

2013 Land use

This sheet provides an estimate of private well extraction using the 2012 aerial image.

Calendar-year Well Extraction Estimate (Acre-feet - AF)

2013 Low* DT**	2013 Average DT	2013 High* DT	Long-term DT
2016	3060	4207	2191

Water-year Well Extraction Estimate (Acre-feet - AF)

2013 Low DT	2013 Average DT	2013 High DT	Long-term DT
1994	3033	4176	2305

Fiscal-year Well Extraction Estimate (Acre-feet - AF)

2013 Low DT	2013 Average DT	2013 High DT	Long-term DT
1707	2635	3661	2331

Determining Factors (Calendar-year)

	2013 Low DT	2013 Average DT	2013 High DT	Long-term DT	Acres Used for DT
Avocado	1.43	1.74	2.05	1.21	130
Cherimoyas / Fruit Trees	1.45	2.15	2.85	2.00	66
Covered Nurseries	2.15	3.22	4.29	3.19	75
Mixed Field Crops	0.47	1.84	3.21	0.65	97
Lemons	0.32	1.53	2.74	0.87	40
Open Nurseries	0.49	1.30	2.12	1.27	31
Turf / Pasture	1.50	1.50	1.50	1.50	****

* Low / High = 95% Confidence Interval Values for Average
** DT = Determining Factors
*** Insufficient number of parcels for calculating values (1); open nursery values entered
**** Derived from long-term rainfall / evapotranspiration data

TECHNICAL MEMORANDUM
Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003
Tel: 805.644.0470
Fax: 805.644.0480

To:	Carpinteria Valley Water District	Date:	April 21, 2014
Attention:	Bob McDonald, P.E. District Engineer	Project No:	06-0127
Copy to:			
From:	Robert Marks, P.G., C.Hg		
Subject:	Carpinteria Groundwater Basin Hydrologic Budget Update, Water Years 2009 - 2013		

Introduction

Presented in this Technical Memorandum (TM) is documentation of our findings, conclusions and recommendations developed from an update to the hydrologic budget for the Carpinteria Groundwater Basin (CGB). The hydrologic budget quantifies the primary sources of recharge and discharge in the groundwater basin. The hydrologic budget for the CGB was last updated by Pueblo Water Resources, Inc. (PWR) for the period of Water Years (WY) 1985 through 2008 as part of the development of a numerical groundwater model of the CGB[1]. The subject update covers the period of WY 2009 through WY 2013.

Background

A hydrologic budget for a groundwater basin is an inventory of the various sources of recharge and outflow in the basin, and is expressed by the following equation:

Inflow = Outflow (+/-) Change in Storage

where Inflow equals:

- Subsurface Inflow
- Streambed Percolation
- Percolation of Precipitation, and
- Percolation of Irrigation Return Water (pumped and imported);

and Outflow equals:

- Subsurface Outflow

[1] *Carpinteria Groundwater Basin, Hydrogeologic Update and Groundwater Model Project Final Report*, prepared by Pueblo Water Resources, Inc. for Carpinteria Valley Water District, dated June 30, 2012.

- Gross Groundwater Pumpage, and
- Extraction by Phreatophytes.

The hydrologic budget for the CGB has been developed through three previous investigations performed for the CVWD:

1. Geotechnical Consultants (GTC) performed an inventory of the various components of inflow and outflow to the CGB in its 1976 study of the basin for WY 1935 through WY 1973 (39-year base period).

2. GTC subsequently updated the inventory in 1986 for WY 1974 through WY 1984 (11-year base period).

3. PWR updated the hydrologic budget for WY 1985 through WY 2008 (24-year base period) as part of a 2012 hydrogeologic update and groundwater model project.

Some hydrologic budget data are available via direct measurement (e.g., metered pumpage), whereas others are more difficult to quantify and require estimation based on commonly used methods. In general, the methods used in PWR's 2012 analysis were very similar to those used by GTC in their 1976 and 1986 inventories, but were modified and improved where possible given the availability of new data and/or analytic tools. Utilizing consistent methods for the updated base-period allowed for reasonable comparison and correlation with the previous estimates for the various base-periods. The results of combining all three of the above base-period inventories into a single 74-year base period of WY 1935 – WY 2008 indicated a long-term annual average recharge rate for the CGB of approximately 4,200 afy and an extraction rate of approximately 3,800 afy, corresponding a long-term average annual accumulation in storage of approximately 400 afy.

Since the last update of the hydrologic budget, however, California has experienced several years of deficient rainfall, and the State has just recently declared a drought emergency. As a result, identification and quantification of the impacts of the recent drought on the amount of recharge and cumulative changes in storage for the CGB are of increasing importance to CVWD's ongoing management of the basin. The subject update to the hydrologic budget for the CGB picks up where the last update ended and covers the new 5-year period of WY 2009 through WY 2013.

FINDINGS

For this project, the hydrologic budget inventory was updated utilizing the same methods that were developed for the 2012 hydrogeologic update and groundwater model project. Detailed descriptions of the methods and calculations used for each component of the hydrologic budget for the CGB are presented in PWR's 2012 report and will not be repeated here. A summary of the updated hydrologic budget for the WY 1985 – WY 2013 period (29 years) is presented in **Table 1**. The values shown in **Table 1** are also presented graphically on **Figure 1**. Summary descriptions for component of the hydrologic budget are presented below:

Table 1. Hydrologic Budget Summary, WY 1985 – WY 2013

		INFLOW (acre-feet per year)							OUTFLOW (acre-feet per year)						
				Percolation of Precipitation		Percolation of Irrigation Water				Groundwater Pumpage		Extraction by		Change in Storage	
Water Year	Rainfall (in)	Subsurface Inflow	Streambed Percolation	Recharge Area	Confined Area	Delivered	Pumped	Total Inflow	Subsurface Outflow	CVWD	Private	Phreatophytes	Total Outflow	Year	Cummulative
1985	15.26	869	57	391	49	58	190	**1,615**	16	1,836	949	100	**2,901**	-1,287	**-1,287**
1986	25.78	1,100	866	4,198	522	80	208	**6,973**	0	2,032	1,041	100	**3,173**	3,801	**2,514**
1987	11.99	683	91	30	4	90	186	**1,084**	0	2,363	932	100	**3,395**	-2,312	**202**
1988	17.34	988	112	731	91	103	213	**2,238**	0	2,342	1,065	100	**3,507**	-1,269	**-1,066**
1989	10.27	585	26	0	0	116	304	**1,031**	0	2,984	1,520	100	**4,604**	-3,573	**-4,639**
1990	8.93	509	4	0	0	246	398	**1,157**	0	3,413	1,990	100	**5,503**	-4,346	**-8,985**
1991	20.11	1,100	758	1,634	203	166	452	**4,313**	0	3,014	2,261	100	**5,375**	-1,062	**-10,047**
1992	25.39	1,100	1,026	4,174	519	140	433	**7,392**	0	1,560	2,165	100	**3,825**	3,567	**-6,480**
1993	37.45	1,100	1,434	5,499	683	177	484	**9,378**	0	1,261	2,422	100	**3,783**	5,596	**-884**
1994	14.43	822	352	278	35	184	564	**2,234**	0	1,307	2,818	100	**4,225**	-1,991	**-2,875**
1995	41.59	1,100	1,746	5,487	660	162	478	**9,632**	231	1,291	2,389	100	**4,011**	5,621	**2,746**
1996	19.55	1,100	894	1,401	168	162	502	**4,227**	239	1,557	2,510	100	**4,406**	-178	**2,568**
1997	18.07	1,030	958	862	104	192	487	**3,633**	58	1,317	2,437	100	**3,912**	-280	**2,288**
1998	51.48	1,100	1,744	5,467	657	149	486	**9,602**	418	575	2,428	100	**3,521**	6,081	**8,369**
1999	9.99	569	434	0	0	292	598	**1,893**	376	340	2,990	100	**3,806**	-1,913	**6,456**
2000	17.47	995	789	740	88	256	621	**3,489**	86	1,410	3,105	100	**4,702**	-1,213	**5,243**
2001	20.43	1,100	1,096	1,692	205	205	652	**4,950**	202	185	3,259	100	**3,746**	1,204	**6,448**
2002	7.66	436	7	0	0	257	621	**1,320**	196	558	3,103	100	**3,957**	-2,637	**3,811**
2003	21.97	1,100	521	2,293	276	245	545	**4,981**	62	402	2,723	100	**3,287**	1,694	**5,505**
2004	9.57	545	2	0	0	277	561	**1,385**	4	999	2,803	100	**3,906**	-2,520	**2,985**
2005	37.56	1,100	1,657	5,366	646	289	412	**9,471**	0	1,152	2,060	100	**3,312**	6,159	**9,144**
2006	18.58	1,059	927	930	112	316	417	**3,759**	0	1,120	2,083	100	**3,302**	457	**9,601**
2007	7.11	405	9	0	0	410	501	**1,325**	0	1,418	2,507	100	**4,025**	-2,700	**6,901**
2008	17.51	998	1,041	683	82	317	561	**3,683**	0	661	2,806	100	**3,567**	116	**7,017**
2009	13.19	752	13	108	13	396	457	**1,738**	0	1,628	2,284	100	**4,012**	-2,274	**4,743**
2010	19.75	1,100	671	1,407	169	335	513	**4,196**	0	1,053	2,566	100	**3,719**	476	**5,219**
2011	24.89	1,100	1,053	3,515	423	324	500	**6,915**	0	1,236	2,502	100	**3,838**	3,077	**8,296**
2012	9.83	560	7	0	0	397	490	**1,454**	0	1,015	2,451	100	**3,566**	-2,112	**6,184**
2013	8.33	475	0	0	0	436	607	**1,518**	0	643	3,033	100	**3,776**	-2,259	**3,926**
5-Yr Avg.	15.20	797	349	1,006	121	378	513	**3,164**	0	1,115	2,567	100	**3,782**	-618	
High	24.89	1,100	1,053	3,515	423	436	607	**6,915**	0	1,628	3,033	100	**4,012**	3,077	
Low	8.33	475	0	0	0	324	457	**1,454**	0	643	2,284	100	**3,566**	-2,274	
% of Total		25	11	32	4	12	16	**100**	0	29	68	3	**100**		
29-Yr. Avg.	19.36	879	631	1,617	197	234	463	**4,020**	65	1,403	2,317	100	**3,885**	135	
High	51.48	1,100	1,746	5,499	683	436	652	**9,632**	418	3,413	3,259	100	**5,503**	6,159	
Low	7.11	405	0	0	0	58	186	**1,031**	0	185	932	100	**2,901**	-4,346	
% of Total		22	16	40	5	6	12	**100**	2	35	58	2	**97**		

Rainfall

Rainfall is the primary source of inflow/recharge to the basin, whether it falls directly on the basin and percolates vertically downward through the surface soils and into basin sediments, or falls on adjacent watershed areas and flows into the basin via streambed percolation or subsurface inflow. The Santa Barbara County Flood Control District maintains precipitation data from the Carpinteria Fire Station with a period of record from 1949 to the present. Annual rainfall during the period of record is presented on **Figure 2**. As shown, the mean annual rainfall for this long-term period is 19.6 inches. The mean during the subject 5-year period was 15.2 inches, which is approximately 22 percent lower than the long-term average.

The cumulative departure of annual rainfall from the long-term mean is also plotted on **Figure 2**. The cumulative departure from mean graph is used to identify climatic trends over the period of record. As shown, the cumulative departure curve exhibits a series of cyclic dry and wet periods in the basin over the period of record. The basin has been experiencing an overall dry cycle since WY 1998, and the last two years (WY 2012 and WY 2013) have been particularly dry, with rainfall totals of less than half the long term average.

Review of **Figures 1 and 2** shows that the cumulative change in storage curve (see **Figure 1**) understandably trends similarly to the cumulative departure of annual rainfall curve (see **Figure 2**). For example, the plots show the dry period of the WY 1987 through WY 1990 drought and the corresponding depletion of storage, followed by the wet period of WY 1991 through WY 1998 and the accumulation of basin storage. In particular, the relative lack of rainfall during the subject 5-year period corresponds to lower amounts of recharge / inflow to the basin and a cumulative depletion of storage (particularly the last two years, WY 2012 and WY 2013), as discussed in the following sections.

Subsurface Inflow

Subsurface inflow is flow from consolidated rocks in the hill and mountain areas adjacent to the CGB. A direct relationship between subsurface inflow and precipitation was developed by GTC (1976), and seasonal subsurface inflow for the WY 1985 – WY 2013 base period was estimated using this same relationship. As shown in **Table 1**, for the WY 2009 - WY 2013 period, an average of 797 afy was estimated, compared to 879 afy for the longer-term WY 1985 – WY 2013 period.

Streambed Percolation

There are five principal streams in the CGB; Carpinteria, Gobernador, Santa Monica, Arroyo Parida, and Rincon Creeks. Streambed percolation is assumed to occur only where the stream reaches cross the Recharge Area. Once streamflow reaches the Confined Area, the amount of deep percolation to the main groundwater system is assumed to be insignificant. The 1976 GTC study included an analysis of annual runoff and seepage losses for streams in the basin, and developed runoff vs. streambed percolation relationships for each individual stream. These same relationships were utilized for this update. As shown in **Table 1** above, the average streambed percolation for the 5-year 2009 - 2013 period was estimated at 349 afy, which is approximately 45 percent less than the 631 afy estimated for the WY 1985 - WY 2103 base period.

Percolation of Precipitation

Percolation of precipitation is the most important source of recharge to the basin, accounting for approximately 45 percent of the total inflow. Precipitation recharges the basin principally through deep percolation to the zone of saturation in the Recharge Area. In addition, one of the important findings from calibrating the numerical groundwater flow model of the CGB was that an average of approximately 215 afy (approximately 5 percent of the total inflow) of precipitation percolation in the Confined Area does reach the deep aquifers; therefore, for this update we have also calculated deep percolation in the Confined Area for the entire WY 1985 – WY 2013 period.

The total volume of deep percolation for each year of the base period is shown in **Table 1**. As shown, significant deep percolation only occurs in the wetter years. In years when the average annual rainfall is less than approximately 12 inches, no deep percolation is estimated to occur. Of particular note for this update is that no deep percolation of precipitation was estimated to have occurred in WY 2012 or WY 2013.

For this update, the average annual recharge to the basin during the 5-year WY 2009 – WY 2013 period from deep percolation of rainfall is estimated to be approximately 1,127 afy (1,006 afy in the Recharge Area, and 121 afy in the Confined Area). The total amount of deep percolation during the subject period (1,127 afy) is approximately 38 percent less than the 1,814 afy estimated for the 29-year WY 1985 – WY 2013 base period.

Percolation of Irrigation Water

Percolation of irrigation return water in the CGB is dependent on a variety of factors, including climatic conditions, crop type, and irrigation practices. Studies by the U.S. Soil Conversation Service for Santa Barbara County indicate irrigation efficiencies range from 65 to 70 percent. For purposes of estimating deep percolation of irrigation return water in the CGB, a conservative estimate is that 20 percent of applied water (both pumped and delivered, which includes imported water) percolates into the basin. As shown in **Table 1,** the average annual recharge to the basin during the WY 2009 – WY 2013 period from percolation of irrigation water is estimated to be approximately 891 afy, which is approximately 28 percent greater than the 697 afy estimated for the WY 1985 – WY 2013 base period. The greater than average amount of irrigation return water reflects the increased amount of applied water required to support crops during the WY 2009 – WY 2013 period due to the relative lack of rainfall.

Subsurface Outflow

The quantity of subsurface outflow from the CGB is estimated using Darcy's Law, in which the rate of discharge through a given cross section of saturated material is proportional to the hydraulic gradient. The hydraulic gradient is driven by water-levels in the basin, and outflow occurs only when there is a seaward gradient (i.e., when water levels are generally above sea level). The results of the subsurface outflow calculations are shown in **Table 1**. As shown, zero subsurface outflow was estimated during the WY 2009 – WY 2013 period because the seaward gradient between the coast and inland portions of the basin was reversed (i.e., water levels were lower inland than at the coast). It is noted that the existing reversal of the naturally occurring seaward gradient creates conditions for the potential for seawater intrusion into the basin to occur.

Groundwater Pumpage

Groundwater extractions from the CGB occur from both District and private production wells. District well production is metered, and monthly totals of production from the District wells were compiled for the WY 2009 – WY 2013 period. Private pumping in the basin is not metered and has been estimated on an annual basis by the District since 1984 utilizing land use survey and water delivery information. As shown in **Table 1**, aggregate pumpage is estimated to have averaged approximately 3,682 afy (1,115 afy from CVWD wells and 2,567 afy from private wells) during the WY 2009 – WY 2013 period. This amount of pumpage is comparable to the long-term average of approximately 3,720 afy estimated for the WY 1985 – WY 2013 period.

Extraction by Phreatophytes

Phreatophytes are water loving plants (roots extend into the water table) that live in the vicinity of stream channels and in areas of high groundwater. Groundwater consumed by phreatophytes is dependent on many factors, including plant species, vegetative density, climate, soil types and conditions, and depth to groundwater. Direct measurements of consumptive use by phreatophytes in the CGB do not currently exist. By applying the results of study in San Diego County (Blaney and Criddle, 1963), extractions by phreatophytes have been roughly estimated to be approximately 100 afy. As shown in **Table 1**, phreatophytes consumption is estimated to be a relatively insignificant portion (2 percent) of the outflow from the basin.

Changes in Storage

The change in the amount of groundwater in storage depends on the annual water supply surplus or deficiency, as expressed in the water balance equation. As shown in **Table 1**, average annual outflow during the 5-year WY 2009 – WY 2013 period was estimated at 3,782 afy and the average annual inflow estimated at 3,164 afy, resulting in a net average annual storage depletion of approximately 618 afy during the 5-year period. This compares to the estimated average annual inflow during the 29-year WY 1985 – WY 2013 period of approximately 4,020 afy and average annual outflow of approximately 3,885 afy, corresponding to a slight accumulation of groundwater in storage of approximately 135 afy.

As noted previously, the hydrologic budget for the CGB has been developed through three previous investigations performed for the CVWD, and the methodologies utilized for the various inventories of each base period were similar (but not identical). A comparison of the estimated amounts of average annual total inflow, outflow, and changes in storage for the four base periods is presented in **Table 2** below:

Table 2. Hydrologic Budget Comparison

Base Period	Period Years	Investigator	Avg. Rainfall (in)	Inflow (afy)	Outflow (afy)	Change in Storage (afy)
1935 – 1973	39	GTC	17.8	4,194	3,777	+416
1974 – 1984	11	GTC	23.6	4,858	3,430	+1,428
1985 – 2008	24	PWR	19.4	3,988	3,906	+82
2009 – 2013	5	PWR	15.2	3,164	3,782	-618

Both **Tables 1 and 2** and **Figures 1 and 2** show that there is a direct and obvious correlation between the amount of average annual rainfall and changes in basin storage. For example, during the WY 1985 – WY 2008 period when rainfall was close to the long-term average of 19.6 inches per year, the basin was essentially in balance with an average annual inflow of approximately 4,000 afy. Average annual rainfall during the subject 5-yr period was only 15.2 inches, which is approximately 22 percent lower than the long-term average, and has resulted in a net storage depletion of approximately 618 afy during the period.

As shown in **Table 1** and **Figure 1**, the cumulative storage volume in the CGB is still positive relative to basin conditions in WY 1984 (when it was in a relatively “full” condition) and particularly at the end of the WY 1987 through WY 1990 drought, when it was depleted by as much as 10,000 af (water levels in the basin were over 50 feet below sea level in portions of the Confined Area during this period). The two most recent water years (WY 2012 and WY 2013) have been particularly dry, however, with rainfall totals less than half the long-term average. The corresponding storage depletion the last two years has averaged approximately 2,200 afy. WY 2014 is on track to be similarly dry, representing a third consecutive year of drought conditions, and additional storage depletion likely continues to occur.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings developed from the subject 5-year update to the CGB hydrologic budget for WY 2009 – WY 2013, we offer the following conclusions and recommendations:

- Average rainfall during the subject WY 2009 – WY 2013 period was approximately 15.2 inches, which is approximately 20 percent less than the long-term average of 19.6 inches. The last two years of the period (WY 2012 and WY 2013) were particularly dry, with annual rainfall totals of approximately 9.8 and 8.3 inches, respectively, which are less than 50 percent of the long-term average.

- The limited amounts of rainfall during the period correspond to lower-than-average recharge to the CGB. Average total inflow / recharge during the period is estimated to be approximately 3,160 afy, which is approximately 20 percent less than the long-term average of approximately 4,020 afy. During the last two years, however, total recharge has been estimated at approximately 1,500 afy, which is approximately 60 percent less than the long-term average.

- Extractions from the basin during the 5-year period have averaged approximately 3,700 afy, which is generally consistent with the long-term average.

- As a result of the relatively limited amount of recharge and extractions remaining near their long-term average, an average of approximately 620 afy of storage depletion is estimated to have occurred, corresponding to a cumulative storage loss of approximately 3,100 af over the 5-year period. Most of this change / loss in storage occurred during the last two years of the period, with over 2,000 afy of storage depletion estimated each year.

- The hydrologic budget for the CGB should be updated on an ongoing basis. Given the current drought conditions are persisting through WY 2014, it is recommended that the hydrologic budget be updated on annual basis until the drought is over. When climatic conditions return to normal, the hydrologic budget should continue to be updated, but perhaps on a less frequent basis (e.g., tri-annually).

- There was no subsurface outflow estimated during the period (no subsurface outflow has been estimated to have occurred during the last 9 years) due to depressed water levels in the basin. Water levels are as much as 15 feet below sea level in the western portion of basin, an area where the Rincon Creek Fault barrier is located offshore. These basin conditions present a theoretical risk for seawater intrusion to occur in the CGB.

- Although seawater intrusion has not historically been detected in the CGB, given that water levels are currently below sea level, and have historically been at even greater levels below sea level during previous drought periods, there is a potential risk for seawater intrusion to theoretically occur. In order to mitigate this risk and provide an "early warning" system for the potential threat of seawater intrusion, we recommend the installation of dedicated "sentinel" monitoring wells at the shoreline. Individually screened and sealed monitoring wells should be placed within the shallow aquifer as well as in the deeper Aquifers A, B and C (4 wells total). The wells should then be added to existing monitoring program of the Groundwater Management Plan for the CGB and routinely monitored for water levels and various water quality parameters.

CLOSURE

This Technical Memorandum has been prepared exclusively for Carpinteria Valley Water District for the specific application to the Carpinteria Groundwater Basin Hydrologic Budget Update Project. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeologic practices. No other warranty, express or implied, is made.

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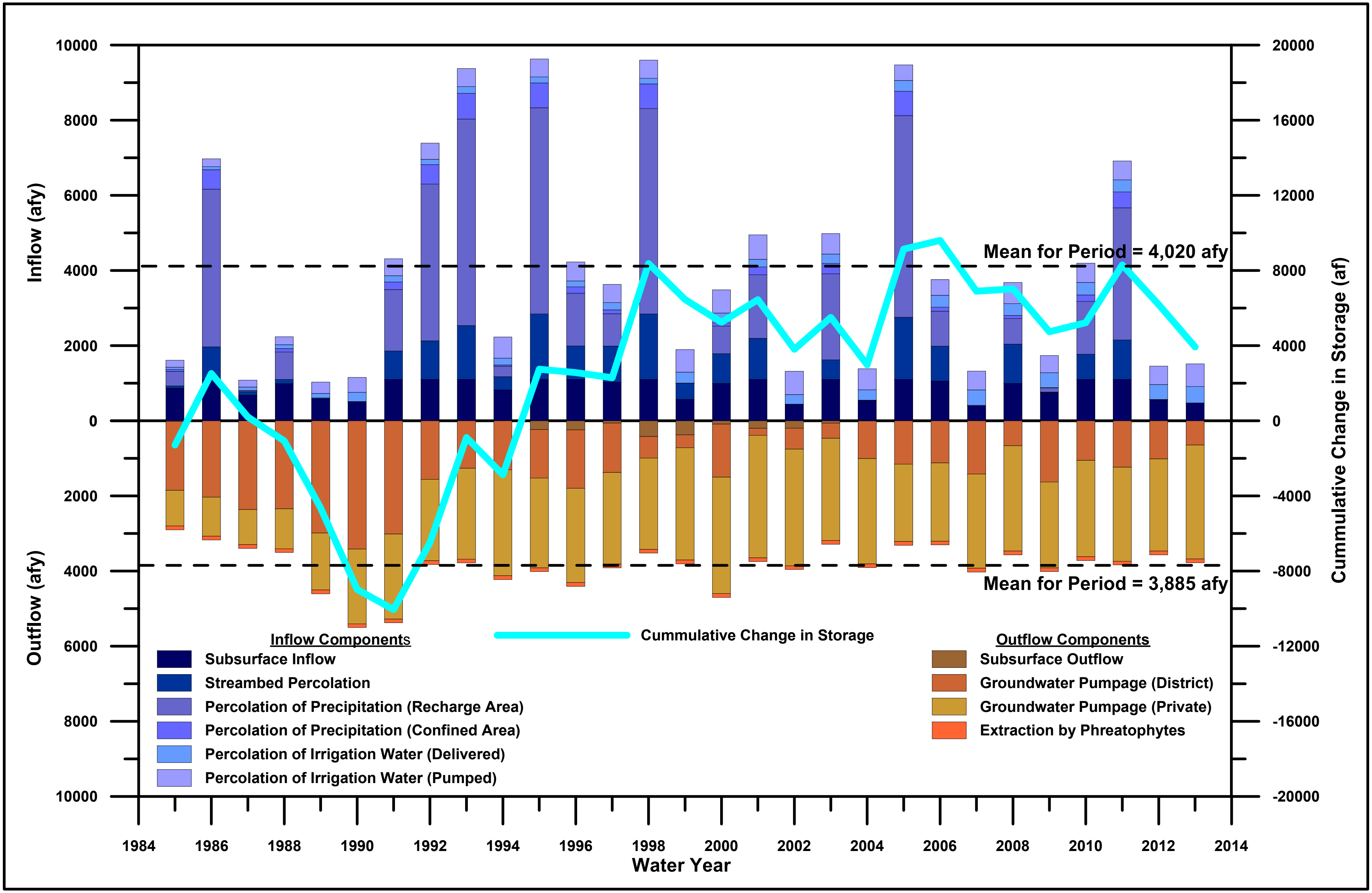
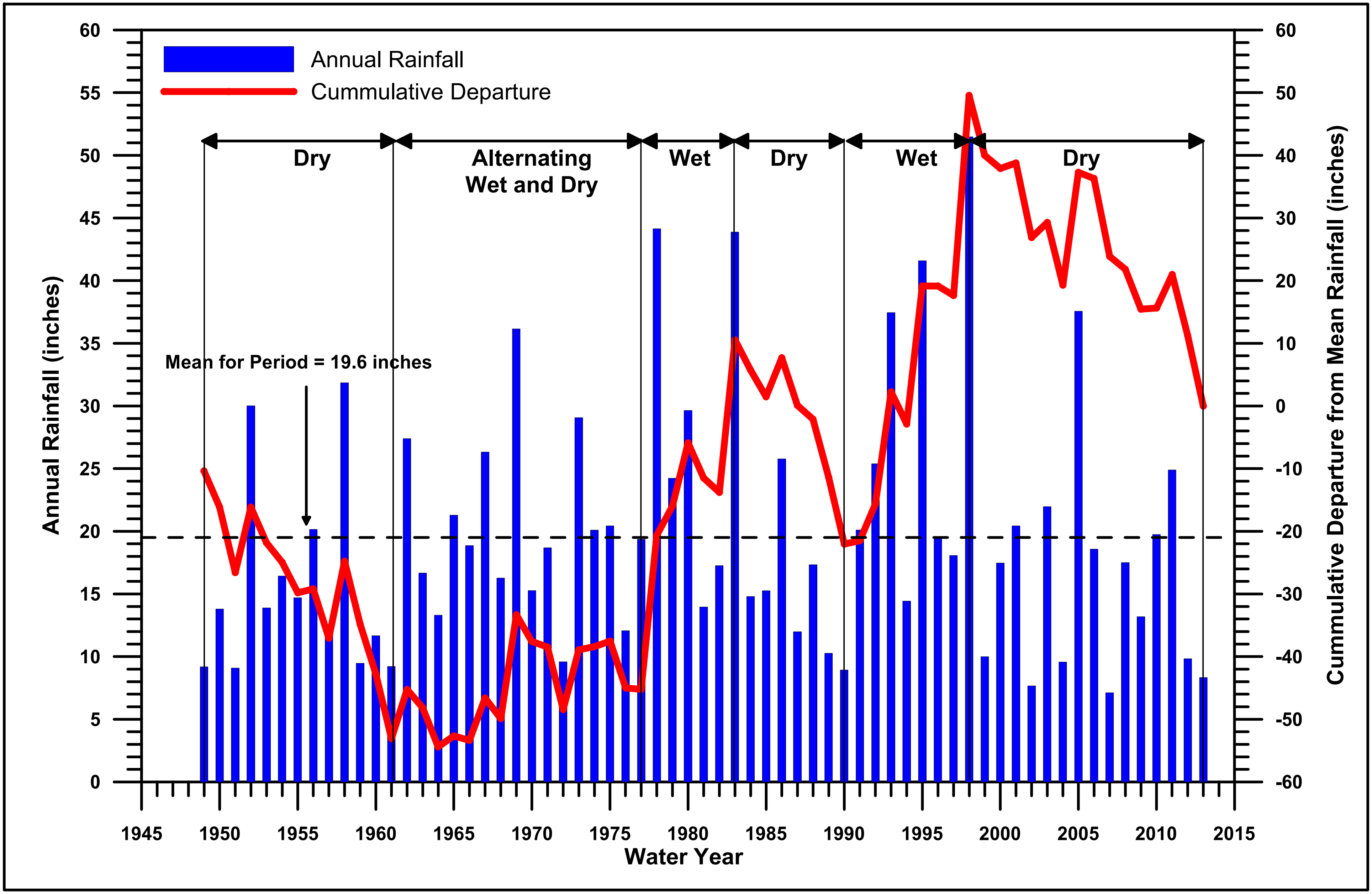
April 2014
Project No. 06-0127



PUEBLO water resources

FIGURE 1. HYDROLOGIC BUDGET SUMMARY FOR 1985 - 2013 BASE PERIOD
CGB Hydrologic Budget Update Project
Carpinteria Valley Water District

April 2014
Project No. 06-0127



PUEBLO water resources

FIGURE 2. CUMULATIVE DEPARTURE OF ANNUAL RAINFALL - CARPINTERIA FIRE STATION (208)
CGB Hydrologic Budget Update
Carpinteria Valley Water District