Technical Memorandum #3
Groundwater Model Mudflow Simulations

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TECHNICAL MEMORANDUM NO. 3

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TO: John Gray - URS Corp. **DATE:** July 19, 2004

FROM: Peter Pyle, Curtis Lawler - Stetson Engineers **JOB NO:** 1944

RE: **Solvang EIR Groundwater Model Modflow Simulations**

1. INTRODUCTION

The purpose of this study was to develop a Modflow ground and surface water model for evaluation of proposed increased pumping by the City of Solvang (Solvang) from the Santa Ynez River alluvium. The groundwater model represents the Santa Ynez River alluvium below Bradbury Dam from approximately three-quarters of a mile downstream from the Highway 154 Bridge to about one mile below the Alisal Road Bridge (Figures 1a and 1b). The model was calibrated monthly for the period 1982 through 93. Three predictive scenarios were simulated monthly using hydrologic data for the period 1953 through 1993, modified for various Cachuma Reservoir release criteria and increased Solvang pumping. The Modflow simulations are used to assess relative impacts of the increased Solvang pumping on drawdowns in the river alluvium and possible well interference on the Improvement District No. 1, Santa Ynez River Water Conservation District (ID No. 1) well fields.

This technical memorandum is the third in a series in preparation for the City of Solvang's CEQA environmental document in connection with the petition to the State Water Resources Control Board (SWRCB) for extension of time for Permit 15878. Technical Memorandum No. 1 entitled "Hydrologic Impact Analyses..." dated April 23, 2004 provides the results of hydrologic analyses on Cachuma Reservoir operations, Santa Ynez River flows, above Narrows groundwater storage, water right releases, and Cachuma Project deliveries. Technical Memorandum No. 2 entitled "Water Quality Impact Analyses..." dated May 10, 2004 provides the results of hydrologic analyses on impact to the total dissolved solids (TDS) concentration of the Santa Ynez River flow at Lompoc Narrows.

2. DESCRIPTION OF MODEL

The model cells are 200 feet square or slightly less than one acre in area. These dimensions were developed to conform to the sinuous nature of the geologic contacts and the Santa Ynez River channel, and to allow for reasonable resolution of simulated water levels, given the close spacing of some pumping and monitoring wells.

2.1 GEOLOGY AND MODEL BOUNDARIES

The lateral extent of the model boundaries are based on the most recent and detailed geologic maps by Dibblee (1988) (Figure 2). There are 1,820 active cells representing a total of 1,671 acres. The Santa Ynez River and alluvial deposits (Qa and Qg) are used to define the extent of the River alluvium (Figure 3). These units are generally confined topographically within the steep banks of the river bed and bounded by Tertiary fine grained consolidated rocks of low permeability such as the Monterey Shale. In areas where older alluvium or landslides bound the River alluvium, these units occur at generally higher elevations and are relatively shallow, overlying low permeability rocks. The Santa Ynez Upland groundwater basin is located to the north and separated from the River alluvium by the Monterey Shale.

Probably the least well defined lateral boundary is near the confluence of Alamo Pintado Creek and the Santa Ynez River. Monterey Shale inliers and topography hint at a shallow buried shelf of shale, the presence of which has been confirmed by aquifer testing of Santa Ynez River Water Conservation District – Improvement District No. 1 (ID No. 1) wells near the northern boundary in this area (Figures 2 and 3). The lateral boundaries of the River alluvium as originally defined by USBR in the 1970's and currently used in their monthly dewatered storage calculations, are generally wider than those determined from more detailed geologic mapping and later water level, and well drilling and testing data.

The base of the River alluvium is easily distinguished in drillers logs as it is consists primarily of lower permeability consolidated rocks that also form the lateral boundaries. The thickness of the River alluvium was determined from drillers logs and bridge borings and ranges from about 35 feet to over 60 feet in the model area. An average thickness of 50 feet was used throughout the model due to limited time and data to develop a thickness value for all areas. The saturated aquifer thickness that resulted from this assumption ranged widely due to the varying topography of the modeled area. The average saturate thickness of the aquifer at a simulated full water level was generally in the range of 30 to 40 feet.

The upstream boundary of the model coincided with the upstream boundary of USBR Node 23 and a constant flux was input at this boundary to represented subsurface flow based on data from the Santa Ynez River Hydrology Model (SYRHM), developed by the Santa Barbara County Water Agency. The downstream boundary of the model coincides with the west side of USBR Node 18. The model cells on that boundary allow subsurface outflow to vary with groundwater elevation. In general, the outflow amount was about twice that calculated by the SYRHM for the nearest upstream node. This increase was assumed to be valid due to the greater width of the alluvial aquifer at the boundary.

2.2 AQUIFER PROPERTIES

The alluvial deposits between the Highway 154 Bridge and the Alisal Road Bridge are described as comprising of primarily medium to coarse sand and fine gravel with very little silt (Upson and Thomasson, 1951 and Dibblee, 1988). Upson and Thomasson collected four samples in the Santa Ynez River alluvium from Bradbury Dam to Solvang and performed laboratory tests in which the permeability (K) ranged from 100 to 600 feet/day (ft/d). Recovery pumping tests were also performed in the Santa Ynez River alluvium further downstream near the Santa Rosa dam site and upstream of the present Bradbury damsite, in which permeability ranged from 100 to 700 feet/day. Because the alluvial deposits are generally coarser further upstream, Upson and Thomasson ended up choosing a K value of 530 ft/d for a Santa Ynez River subflow calculation at both the Highway 154 and Alisal Road Bridges.

Well test data from Stetson Engineers' files were used to supplement the conductivity distribution in the model area. (Note: The term hydraulic conductivity is used herein interchangeably with the term permeability.) Data from a recent study for the City of Solvang (Hopkins, 2003) was also used to evaluate aquifer characteristics in the Solvang area. These data indicated the range of hydraulic conductivity in the Solvang area ranged from about 100 to over 1,000 ft/d and averaged 470 ft/d. This area was assigned a hydraulic conductivity of 500 ft/d. Below Solvang a value of 300 ft/d was determined through calibration to limit subsurface outflow to a reasonable range.

In the river reach including the ID No. 1's 6 cfs well field a value of 650 ft/d was used based on data from four well tests that ranged from 550 ft/d to over 1,000 ft/d (Table 1). A value toward the lower end of the range is more consistent with local water level data. There were no aquifer test data available for this study in the central portion of the model area. A value

TABLE 1
AQUIFER PROPERTIES BASED ON AQUIFER TESTS

	Method	Source	Date	Test Length	Pump Rate (gpm)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Transmissivity (ft^2/day)	Static W.L. (ft)	Qg,Qal Depth (ft)	Sat. Thick. (ft)	Hydraulic Conductivity K (gpd/ft^2)	Hydraulic Conductivity K (ft/day)	Comments
ID1- 4 cfs Well Field														
Well #12	semi-log	Stetson	12/29/83	24 hr	720-738, 730 avg		90,000	12,000	9	57	48	1,900	250	
Well #13	semi-log	Stetson	1/25/84	8.6 hr	722 const.		238,000	31,800	12	60	48	5,000	660	
Well #14	specific capacity	Stetson	2/8/84	7.3 hr	500-1100 step		119,000	15,900	10.05	54	44	2,700	360	
Well #14	semi-log	Stetson	2/8/84	16 hr	908 const.		160,000	21,400	10.26	54	44	3,700	490	
Well #17						18								
Well #18						23								
K avg all tests													**440**	
ID1- Gallery	specific capacity	Stetson	4/4/84	22 hr	1700-1770	200	350,000	46,800	8	25	17			SC = 200; Theis doesn't apply to gallery well to estimate K.
ID1- 6 cfs Well Field														
Well #8	semi-log	Stetson	Jan 82	24 hr	608		160,500	21,500	11	37	26	6,200	830	bdry @70min
Well #9	semi-log	Stetson	Jan 82	24 hr	825		280,000	37,400	8	40	32	8,800	1,170	bdry @200min
Well #10	semi-log	Stetson	12/6/83	14 hr	771-834, 800 avg		136,000	18,200	12	45	33	4,100	550	poor data
Well #11	semi-log	Stetson	12/6/83	9.7 hr	786+/-		335,000	44,800	9	47	38	8,800	1,180	
K avg all tests													**930**	
Alisal Ranch Wells														
Well #2		Hopkins	unknown	30 min	600	122.7	184,000	24,600	11.9	41.5	25	7,400	980	short test
Well #2		Hopkins	unknown	60 min	230	93.9	140,800	18,800	21.25	54	30	4,700	630	short test
Well #2		Hopkins	unknown	60 min	410	51.6	77,400	10,300	21.25	54	25	3,100	410	short test
Well #2		Hopkins	unknown	60 min	575	42.4	63,700	8,500	21.25	54	19	3,400	450	short test
Well #3		Hopkins	unknown	60 min	175	22.9	34,400	4,600	23.87	56	25	1,400	180	short test
Well #3		Hopkins	unknown	60 min	310	23.0	34,400	4,600	23.87	56	19	1,800	240	short test
Well #3		Hopkins	unknown	60 min	375	17.0	25,500	3,400	23.87	56	10	2,600	340	short test
K avg all tests													**461**	
Solvang Wells														
Well #3 (5A)		Hopkins	unknown	60 min	200	43.5	65,200	8,700	12.7	43	26	2,500	340	short test
Well #3 (5A)		Hopkins	unknown	60 min	400	34.8	52,200	7,000	12.7	43	19	2,700	370	short test
Well #3 (5A)		Hopkins	unknown	60 min	477	21.9	32,800	4,400	12.7	43	9	3,600	490	short test
Well #3 (5A)		Hopkins	unknown	60 min	423	20.3	30,500	4,100	12.7	43	10	3,100	410	short test
Well #3 (5A)		Hopkins	unknown	60 min	400	22.0	33,000	4,400	11.8	43	13	2,500	340	short test
Well #5	specific capacity	Stetson	82 op data		825		67,500	9,000			40	1,700	230	
Well #5		Hopkins	1957	unknown	1250	35.7	53,600	7,200	1	40	4	13,400	1,790	too high
Well #5		Hopkins	1957	unknown	1000	30.3	45,500	6,100	1	40	6	7,600	1,010	too high
Well #5		Hopkins	1957	unknown	750	31.3	46,900	6,300	1	40	15	3,100	420	
Well #5		Hopkins	1957	unknown	500	31.3	46,900	6,300	1	40	23	2,000	270	
Well #5		Hopkins	1957	unknown	677	54.2	81,200	10,900	0.5	40	27	3,000	400	
Well #6	specific capacity	Stetson	82 op data		725		48,000	6,400			40	1,200	160	
Well #7		Hopkins	1985	40 hr	405	18.0	27,000	3,600	14.1	48	11	2,500	330	
Well #7A (7R)		Hopkins	unknown	unknown	500	15.5	23,200	3,100	7.7	55	15	1,500	210	
Well #7A (7R)		Hopkins	unknown	unknown	400	13.9	20,800	2,800	7.7	55	19	1,100	150	
Well #7A (7R)		Hopkins	unknown	unknown	300	13.5	20,200	2,700	7.7	55	25	800	110	
Well #7		Stetson	unknown	unknown	400		43,000	5,700			34	1,300	170	
Solvang Well Field		Stetson										3,500	470	Well influence calcs 8/6/1970
K avg all tests													**426**	

of 700 ft/d was assigned to the model based on test data from upstream and downstream reaches and the assumption that this area may contain more coarse material due to its narrower width and steeper river gradient.

The hydraulic conductivity in the upper portion of the model area was assigned a value of 500 ft/d based on well test data from three wells in the ID No. 1's 4 cfs well field which averaged 440 ft/d, and well logs showing coarse aquifer material upstream near the model boundary. The final distribution of hydraulic conductivity is shown in Figure 4.

Wilson of the USGS analyzed four well logs in this area of the river alluvium and estimated a specific yield of 0.247 (Wilson, 1958). A uniform specific yield value of 0.23 was used throughout the model area due to a lack of direct test data and based on an average of values used by USBR in their nodal storage calculations in the model area (Toups Engineering, 1972).

2.3 SIMULATED HYDROLOGIC FEATURES

The model was used to simulate the following hydrologic features:

- Pumping wells in the River alluvium – ID No. 1, Solvang, private irrigation
- Santa Ynez River flow – Modflow STR Package
- Tributary inflow – added at confluence of each tributary with the SY River
- Recharge from precipitation – based on data from the SYRHM
- Recharge from the Solvang Waste Water Treatment Plant (WWTP) – based on data collected by the Santa Barbara County Water Agency (Ahlroth, 1996)
- Phreatophyte evapotranspiration (ET) – based on orthophoto quads (USGS, 1994) and density rated consumptive use (Blaney and Nixon, 1963)
- Subsurface Inflow – based on data from the SYHRM
- Tributary stream recharge – based on Darcy's law
- Subsurface Outflow – using head dependent flux cells, Modflow GHB package

The pumping well locations shown in Figures 1a, 3 and 4 are those used for the Solvang EIR simulations. However, only the locations of Solvang and ID No. 1 wells existing at the time of calibration were used during the calibration period. The location of irrigation wells operating during the calibration period and their rates of pumping are unknown but were estimated from Stetson Engineers records and previous studies by others. All irrigation wells for the calibration

and predictive simulations were assumed to have the same pumping rate and seasonal distribution. Monthly net irrigation (agricultural and golf course) pumping was developed from the SYRHM and distributed equally among the 12 irrigation wells used in the simulations. The historical monthly pumping volumes used during the model calibration period are shown in Figure 5. These historical pumping quantities used from the SYRHM were developed in consultation with the Santa Ynez River Hydrology Committee (Ahlroth, 1996). The committee is comprised of water specialists and hydrologists, primarily representing local interests.

Various other hydrologic budget parameters from the SYRHM were utilized in the development of the groundwater model input data sets. Refer to Stetson Engineers Technical Memorandum No. 1, entitled Hydrologic Impact Analyses for City of Solvang's CEQA Environmental Document for a Time Extension for Water Rights Permit 15878, dated April 23, 2004, for a more detailed description of the SYRHM. Also the Santa Ynez River Hydrology Manual by the Santa Barbara County Water Agency and updated by Stetson Engineers in April 2004 contains even a more detailed description of the SYRHM.

The SYRHM was used to calculated surface flow inputs used in the groundwater model, including the Santa Ynez River and tributary surface flows. The majority of the surface flows input into the Modflow model (about 86%) comes from the Santa Ynez River at the upstream model boundary (USBR Node 23) (Figure 1). Major tributaries account for about 13% of surface flows entering the groundwater model and include Quiota and Alisal Creeks from the South and Sanja de Cota and Alamo Pintado Creeks from the north. Minor and unnamed drainages account for about 1% of the surface inflow to the model area.

The SYRHM was also used to determine areal recharge to the groundwater model. Annual recharge from precipitation calculated by the SYHRM was distributed monthly based on precipitation for a given year and distributed evenly over all active model cells. Areal recharge is minor compared to recharge from the River. Other components of inflow and outflow from the SYRHM, including bank flows and net municipal pumping from Solvang and ID No.1 municipal wells were based on reported data or estimates.

2.4 CALIBRATION

The model was calibrated monthly over the period 1982 – 1993 (October 1981 through September 1993). The primary calibration targets were USBR nodal well water level data which were available monthly throughout the period and model area. In addition, model budget terms such as ET, subsurface outflow and groundwater storage, as well as measured and SYRHM

simulated stream flows at the Alisal Bridge gage were used for evaluation of the calibration (see Table 2). The primary calibration variables were hydraulic conductivities, stream stage, stream bed conductance and ET rate. The model required a significant amount of refinement to land surface and stream bed elevations as the most detailed USGS digital elevation data were not sufficiently precise to allow automated assignment of these elevations in most areas.

The stream bed conductance was reduced by 50% below the initial value of 200,000 square feet per day (ft^2/d) calculated from an average stream segment dimensions and estimated vertical permeability. This change reduced the infiltration of low flows in the uppermost reaches but could be reduced further to better match the flow frequency curve at Alisal. In order to most accurately simulate River flow and seepage, the number of cells representing the River and the conductance may need to be adjusted monthly to represent the actual wetted area.

The hydraulic conductivity zones were created from a single initial value and adjusted in size and value within the range established by the test data as discussed above. The ET rate was increased from an estimated density weighted value of 2.5 to 4.0 ft/yr to approximate the ET losses for the model area calculated by the SYRHM. The stream stage was reduced from two to 0.1 feet, which reduced model numerical instabilities.

The model simulates water levels, Santa Ynez River flow, and the budget of the River alluvium in the study area. Hydrographs of water levels at the location of USBR monitoring wells are shown in Figures 6 through 10. In general, there is a good fit of measured and simulated data. The precise location and elevation of the USBR measurement points relative to model surface (from USGS 7.5' digital data) and aquifer base, and stream bed (thalweg) elevations accounts for the offset elevations for some wells. In addition, the river thalweg location and elevation varies in some locations more than others. The simulated water levels are somewhat dampened relative to measured data in some areas. This may be due to high simulated stream recharge during low flows and somewhat low infiltration during high flows due to the use of a single stream cell width and conductance term to represent all River flow conditions.

The groundwater budget for the calibration, as shown in Table 3, indicates an annual reduction in storage of up to 1,200 acre-feet, and groundwater storage recovers each year on average. The net recharge from the river was simulated to average about 3,800 afy, most of which can be attributed to pumping and ET losses. The monthly averages showed that the maximum stream recharge occurs in summer when pumping is greatest, rather than in winter when River flow is greater.

TABLE 2
SUMMARY OF THE HYDROLOGIC BUDGET FOR THE FINAL MODEL CALIBRATION
(Averages for the WY 1982 through 1993 in acre-feet per year)

	Stetson Groundwater Model			
INFLOW (+)	**Stetson Input/Calculated**	**Modflow Package**	**SYRHM [1)]**	**USGS/USBR Gaged/Measured**
Surface Water				
Santa Ynez River In	66,263	Str	66,263	60,753 (at Cachuma)
North Side Tributaries	1,499		1,499	
South Side Tributaries	6,689		6,689	
Groundwater Recharge				
Areal Precipitation	83	Rch	83	
Solvang WWTP	515		NA	
Subflow from Tributary Streams	206 [2)]		NA	
Ag Return Flow	NA		NA	
Sub-Surface Longitudinal Inflow	756	Wel	756	
Total Inflow	**76,011**		**75,290**	
OUTFLOW (-)				
Surface Water				
Santa Ynez River nr Solvang	70,653	Output	71,163	81,659
Total Ground Water Pumping				
Net Agricultural	1,730	Wel	1,730	
ID No. 1	838	Wel	743 [3)]	
Solvang	1,241	Wel		
Evapotranspiration from Phreatophytes	632	Output	672	
Subflow, Santa Ynez River Alluvium	954	Output	900	
Total Outflow	**76,048**		**75,271 [1)]**	
Change in GW Storage	37	Output	19	-351
Net Stream Percolation	3,798	Output	3,288	

NOTES

1) SYRHM does not include Node 18 and part of Node 17, which is in GW model.
The SYRHM also includes a net "bank flow" flux of -63 afy, which is not compatible with Modflow GW budgets

2) Calculated from Q = KIA

3) 743 af M&I pumping in SYRHM is net (already includes return flows).

TABLE 3

ANNUAL AND MONTHLY SUMMARY OF SIMULATED GROUNDWATER BUDGET - FINAL CALIBRATION

Model Run	Santa Ynez River - Final Calibration
Description	Calibrated WY1982-1993
Date	June 29, 2004

ANNUAL MODEL BUDGET

	INFLOW					OUTFLOW									
Water Year	Storage (loss of ground-water in storage)	Recharge (af/y)	Subsurface Upstream (af/y)	Subsurface Downstream (af/y)	Stream Loss to Ground-water (af/y)	Storage (gain of groundwater in storage)	Agriculture Wells (af/y)	Solvang Wells (af/y)	ID No. 1 Wells (af/y)	Total Pumping (af/y)	Phreatophyte Loss (ET) (af/y)	Subsurface Downstream (af/y)	Stream Gain from Ground-water (af/y)	Net Change of Ground- water in Storage	Net Stream Gain+/Loss-
10yr avg anl	640	803	756	0	7,907	34	1,730	1,241	838	3,809	707	1,032	4,551	607	3,356
1982	1,579	618	758	0	5,670	1,561	1,199	1,164	0	2,362	664	994	3,065	17	2,606
1983	156	786	756	0	6,961	86	1,049	831	274	2,154	705	1,021	4,669	70	2,291
1984	1,608	930	756	0	6,931	1,441	1,557	1,335	370	3,261	678	1,011	3,825	166	3,106
1985	2,495	706	756	0	6,159	2,701	1,486	1,382	1,074	3,943	610	916	1,949	-206	4,210
1986	1,166	814	758	0	7,273	1,182	1,569	1,451	794	3,814	691	1,013	3,308	-16	3,965
1987	2,541	806	756	0	5,014	2,078	1,618	1,390	724	3,733	634	977	1,699	463	3,315
1988	3,008	820	756	0	4,805	2,110	1,853	1,399	1,236	4,487	599	982	1,212	898	3,593
1989	2,984	809	756	0	6,233	4,028	1,889	1,305	1,017	4,211	522	832	1,194	-1,044	5,039
1990	3,398	748	758	0	4,063	2,625	1,965	1,250	903	4,118	502	829	895	773	3,168
1991	2,551	749	756	0	6,061	2,396	2,245	1,201	980	4,426	625	825	1,846	154	4,215
1992	1,908	868	756	0	9,357	3,131	2,202	1,304	1,860	5,365	652	1,018	2,727	-1,224	6,630
1993	691	997	756	0	7,433	358	2,128	879	820	3,828	699	1,028	3,994	333	3,439
82-93 avg	**2,007**	**804**	**756**	**0**	**6,330**	**1,975**	**1,730**	**1,241**	**838**	**3,809**	**632**	**954**	**2,532**	**32**	**3,798**
82-93 med	**2,201**	**808**	**756**	**0**	**6,196**	**2,094**	**1,736**	**1,304**	**862**	**3,885**	**643**	**988**	**2,338**	**112**	**3,516**
82-93 min	**156**	**618**	**756**	**0**	**4,063**	**86**	**1,049**	**831**	**0**	**2,154**	**502**	**825**	**895**	**-1,224**	**2,291**
82-93 max	**3,398**	**997**	**758**	**0**	**9,357**	**4,028**	**2,245**	**1,451**	**1,860**	**5,365**	**705**	**1,028**	**4,669**	**898**	**6,630**

AVERAGE MONTHLY MODEL BUDGET

	INFLOW					OUTFLOW									
Month	Storage (loss of ground-water in storage)	Recharge (af/m)	Subsurface Upstream (af/m)	Subsurface Downstream (af/m)	Stream Loss to Groundwater (af/m)	Storage (gain of groundwater in storage)	Agriculture Wells (af/m)	Solvang Wells (af/m)	ID No. 1 Wells (af/m)	Total Pumping (af/m)	Phreatophyte Loss (ET) (af/m)	Subsurface Downstream (af/m)	Stream Gain from Groundwater (af/m)	Net Change of Groundwater in Storage	Net Stream Gain+/Loss-
Oct	211	66	64	0	521	186	147	88	97	332	47	80	214	25	306
Nov	130	71	62	0	252	55	24	62	49	134	28	76	218	75	34
Dec	87	75	64	0	265	68	0	56	37	93	21	78	230	20	35
Jan	72	74	64	0	318	96	0	53	34	87	22	79	243	-24	74
Feb	72	76	58	0	332	79	0	46	68	113	29	73	245	-7	87
Mar	61	76	64	0	593	230	17	58	70	146	48	84	287	-169	306
Apr	126	64	62	0	414	17	52	87	103	242	67	82	261	109	154
May	179	61	64	0	594	172	156	130	77	363	75	85	205	8	389
Jun	303	60	62	0	692	257	329	162	62	553	79	80	149	46	542
Jul	298	60	64	0	689	149	417	182	58	657	81	81	146	149	544
Aug	268	61	64	0	864	378	346	173	50	569	77	79	154	-110	710
Sep	201	61	62	0	796	287	242	144	132	518	58	77	180	-86	617
avg anl	**2,007**	**804**	**756**	**0**	**6,330**	**1,975**	**1,730**	**1,241**	**838**	**3,809**	**632**	**954**	**2,532**	**32**	**3,798**

3. SOLVANG EIR SIMULATIONS

3.1 DESCRIPTION OF SCENARIOS

Three simulations, based on potential Solvang water development scenarios, were developed to evaluate the impact of increased pumping and revised reservoir operations on water levels in the vicinity of existing and proposed Solvang river alluvium wells.

The Solvang pumping conditions evaluated include:

- No change from current river well pumping by Solvang (average 600 afy in years 2000-2002)
- Total river well pumping by Solvang of 2,400 acre-feet per year and maximum diversion rate of 5 cfs per Table 7 of the Water System Master Plan update (Provost and Richard, 2002)
- Total river well pumping by Solvang of 3,600 acre-feet per year and maximum diversion rate of 5 cfs per Permit 15878

Table 4 lists the three scenarios and accompanying reservoir operation conditions.

TABLE 4
CONDITIONS SIMULATED FOR THE CITY OF SOLVANG EIR SCENARIOS

Scenario	Alternatives	Gross Pumping (afy)	Cachuma Reservoir Surcharge (ft)	Fish Flow Operations
GW1	SWRCB EIR Alt 2 with current Solvang pumping 600afy (current operations)	600	0.75	Interim BO/FMP
GW2	SWRCB EIR Alt 3C with Solvang pumping 2400 afy	2,400	3.00	Final BO/FMP
GW3	SWRCB EIR Alt 3C with Solvang pumping 3600 afy	3,600	3.00	Final BO/FMP

The period of the Solvang EIR simulations is October 1952 through September 1993, or 41 years for a total of 492 monthly stress periods. SYRHM data were used for stream flows, areal recharge, and net irrigation pumping. Solvang and ID No. 1 pumping from the River alluvium was assumed as follows:

Solvang Three scenarios as above (600, 3600, 2400 afy)

Monthly distribution from Table 7 of Solvang Water System Master Plan

One existing well (7a) and 6 proposed wells based on Hopkins (2003)

Assume even pumping distribution among the seven wells

Wells 5, 6, and 7 destroyed, Well 3 too close to river per DHS

ID No. 1 Based on average pumpage for 2000 through 2002 = 2,400 afy

2000 through 2002 pumping distribution among wells in each well field

6 cfs WF = 8 wells (8, 9, 10, 19, 20, 21, 22, 23) (Well 11 out of service)

4 cfs WF = 3 wells (14, 17, 18) (Wells 12, 13 out of service)

Tables 5, 6 and 7 list the annual and monthly pumping distribution of Solvang and ID No. 1 wells assumed for these simulations and Figures 11, 12 and 13 show the monthly data graphically by entity. Private irrigation pumping for crops and golf courses using wells located in the river alluvium was calculated monthly by the SYHRM based on acreage and climatic data (Table 8). Irrigation pumping was distributed evenly amongst the 12 irrigation wells used in the simulations.

The locations of wells used in the simulations are shown in Figures 1a, 3 and 4. The locations of Solvang wells is based on Solvang's Water System Master Plan update (Provost and Richard, 2002), and proposed well location maps in a recent report by Hopkins (2003). The ID No. 1 wells used in the simulations include those wells recently pumped (Table 4). The number and location of private irrigation well locations used for the simulations were based on limited well location data from Stetson Engineers' records and Hopkins (2003).

Simulated stream flow for each alternative was calculated by the SYRHM and inputted at the upstream model boundary (USBR node 23). The inflows are shown in Figure 14. There are differences between the simulated Santa Ynez River inflows for Scenario GW1 compared to GW2 and GW3. GW1 represents interim phase fish flow operations under the Biological Opinion (BO) and Lower Santa Ynez River Fish Management Plan (FMP). GW2 and GW3 represent the final phase fish flow operations. One element that is common to both sets of the fish release operating criteria is the conjunctive operation of water rights releases with fish releases. This conjunctive use operation would extend the period of time each year when instream flows improve fisheries habitat for oversummering and juvenile rearing within the mainstem river.

TABLE 5
ANNUAL PUMPING BY THE CITY OF SOLVANG AND ID NO. 1 WELLS FOR SOLVANG EIR SCENARIOS GW1, GW2, AND GW3

	Historical Gross Pumping (afy)					Assumed Gross Pumping in Modflow Analyses for EIR Scenarios (afy)		
Solvang Well Field	**2000**	**2001**	**2002**	**AVG**		**GW1**	**GW2**	**GW3**
Existing Well 7a	787	465	n/a	626		600	343	514
Proposed 1						0	343	514
Proposed 2						0	343	514
Proposed 3						0	343	514
Proposed 4						0	343	514
Proposed 5						0	343	514
Proposed 6						0	343	514
Solvang Sub-Total						**600**	**2,400**	**3,600**
ID No. 1 Santa Ynez Well Fields	**2000**	**2001**	**2002**	**AVG**	**% of Well Field Production**	**% of Well Field Production**	**Gross Pumping (afy) GW1, GW2, GW3**	
6 CFS Well Field								
Well 8	4	218	137	120	7%	7%	126	
Well 9	19	414	355	263	15%	15%	270	
Well 10	15	777	789	527	29%	29%	522	
Well 11		18	47	22	1%	0%	0	
Well 19		-	297	99	5%	5%	90	
Well 20		308	824	377	21%	21%	378	
Well 21		274	342	205	11%	11%	198	
Well 22		-	246	82	5%	6%	108	
Well 23		-	328	109	6%	6%	108	
6 cfs WF Sub-Total				**1,804**		**100%**	**1,800**	
4 CFS Well Field								
Well 12	-	-	-	-	0%	0%	0	
Well 13	332	-	-	111	19%	0%	0	
Well 14	899	37	9	315	55%	60%	360	
Well 17	299	-	5	101	18%	20%	120	
Well 18	130	3	3	45	8%	20%	120	
4 cfs WF Sub-Total				**572**		**100%**	**600**	

TABLE 6
CITY OF SOLVANG SIMULATED MONTHLY DIVERSIONS FROM SANTA YNEZ RIVER WELLS

	% of Annual Demand [3]	Scenario GW1 Solvang River Wells - 600 acre-feet/year		Scenario GW2 Proposed Water System Master Plan [1], Solvang River Wells - 2,400 acre-feet/year		Scenario GW3 Maximum under Permit 15878 [2] Solvang River Wells - 3,600 acre-feet/year	
		Gross Pumping		Gross Pumping		Gross Pumping	
		acre-feet	cfs	acre-feet	cfs	acre-feet	cfs
Jan	*6.25*	37.5	0.61	151	2.46	305.8	4.97
Feb	2.9	17.4	0.31	70	1.26	276.2	4.97
Mar	4.9	29.4	0.48	117	1.90	305.8	4.97
Apr	7.4	44.4	0.75	178	2.99	295.9	4.97
May	8.4	50.4	0.82	202	3.29	305.8	4.97
June	10.8	64.8	1.09	259	4.35	295.9	4.97
Jul	10.6	63.6	1.03	253	4.11	305.8	4.97
Aug	12	72	1.17	288	4.68	305.8	4.97
Sep	12.2	73.2	1.23	293	4.92	295.9	4.97
Oct	8.8	52.8	0.86	211	3.43	305.8	4.97
Nov	8.2	49.2	0.83	196	3.29	295.9	4.97
Dec	*7.55*	45.3	0.74	182	2.96	305.8	4.97
	100	**600**		**2,400**		**3,600**	

Notes

1) *Table 7, Water System Master Plan Update, May 2002, p. 15*
2) *The permit expired in 1990 and the City of Solvang has filed a petition for a time extension with the SWRCB.*
3) *January and December monthly pumping reduced by .05 percent from Table 7 (see note #1) to make annual total equal 100%.*

TABLE 7
ID NO. 1 SIMULATED MONTHLY DIVERSIONS FROM SANTA YNEZ RIVER WELLS

	% of Annual Demand 1)	4 cfs Well Field Gross Pumping		6 cfs Well Field Gross Pumping		Total Gross Pumping	
		acre-feet	cfs	acre-feet	cfs	acre-feet	cfs
Jan	3.8	22.8	0.37	68.4	1.11	91.2	1.48
Feb	3.3	19.8	0.36	59.4	1.07	79.2	1.43
Mar	9.6	57.6	0.94	172.8	2.81	230.4	3.75
Apr	10.4	62.4	1.05	187.2	3.15	249.6	4.19
May	10.6	63.6	1.03	190.8	3.10	254.4	4.14
June	9	54	0.91	162	2.72	216	3.63
Jul	9.7	58.2	0.95	174.6	2.84	232.8	3.79
Aug	11.5	69	1.12	207	3.37	276	4.49
Sep	10.1	60.6	1.02	181.8	3.06	242.4	4.07
Oct	10.8	64.8	1.05	194.4	3.16	259.2	4.22
Nov	6.6	39.6	0.67	118.8	2.00	158.4	2.66
Dec	4.6	27.6	0.45	82.8	1.35	110.4	1.80
	100	**600**		**1,800**		**2,400**	

Notes

1) Based on historical pumping 2000-2002

TABLE 8
AVERAGE NET MONTHLY AGRICULTURAL PUMPING FOR USBR NODES 19-23 FROM SYRHM FOR SOLVANG SCENARIOS GW1, GW2, AND GW3

	% of Annual Demand	Average Net Pumping	
		acre-feet	cfs
Jan	0	0	0.00
Feb	0	0	0.00
Mar	1	17	0.28
Apr	3	52	0.87
May	9	156	2.53
June	19	329	5.53
Jul	24.1	417	6.78
Aug	20	346	5.62
Sep	14	242	4.07
Oct	8.5	147	2.40
Nov	1.4	24	0.41
Dec	0	0	0.00
Sum	100	**1,730**	

Interim (present-condition) flow targets in the Santa Ynez River at the Highway 154 Bridge are shown in Table 9.

TABLE 9
INTERIM MAINSTEM SANTA YNEZ RIVER REARING TARGET FLOWS BASED ON BIOLOGICAL OPINION AND FISH MANAGEMENT PLAN

Lake Cachuma Storage	Reservoir Spill	Target Flow	Target Site
> 120,000 AF	Spill > 20,000 AF	5.0 cfs	Highway 154 Bridge
> 120,000 AF	Spill <20,000 AF or No Spill	2.5 cfs	Highway 154 Bridge
< 120,000 AF	No Spill	1.5 cfs	Highway 154 Bridge
<30,000 AF	No Spill	Periodic Release; ≤30AF per month	Stilling Basin and Long Pool

Source: Lower Santa Ynez River Fish Management Plan, October 2, 2000, pg. 3-12.

In years when Cachuma Reservoir spills 20,000 acre-feet or more, a target flow of 5 cfs will be maintained at the Highway 154 Bridge. In years when Cachuma Reservoir does not spill or spills less than 20,000 acre-feet, the Highway 154 target flow will be determined at the start of each month based on reservoir storage: 2.5 cfs when storage is greater than 120,000 acre-feet and 1.5 cfs when storage is less than 120,000 acre-feet. Periodic releases to refresh the Stilling Basin and Long Pool will be made when storage is less than 30,000 acre-feet. In addition, the BO requires a 2 cfs minimum flow in Hilton Creek once a pump is installed as a part of the terms and conditions to implement Reasonable and Prudent Measure No. 2 of the Biological Opinion. Also, both the BO and FMP under the interim phase include a provision that the U.S. Bureau of Reclamation (USBR) shall maintain residual pool depth in Alisal and Refugio reaches downstream of the Highway 154 Bridge during spill years and the first year after spill years if steelhead are present. Because the quantity of water needed to maintain residual pool depth has not yet been determined and is necessary only when steelhead are present, this provision has not been included in the SYRHM.

Final (long term) flow targets in the Santa Ynez River for steelhead habitat are shown in Table 10.

TABLE 10
FINAL PHASE MAINSTEM SANTA YNEZ RIVER REARING TARGET FLOWS BASED ON BIOLOGICAL OPINION AND FISH MANAGEMENT PLAN

Lake Cachuma Storage	Reservoir Spill	Target Flow	Target Site
> 120,000 AF	Spill > 20,000 AF	10 cfs	Highway 154 Bridge
> 120,000 AF	Spill > 20,000 AF	1.5 cfs[1)]	Alisal Road Bridge
> 120,000 AF	Spill <20,000 AF or No Spill	5 cfs	Highway 154 Bridge
< 120,000 AF	No Spill	2.5 cfs	Highway 154 Bridge
>30,000 AF	Spill < 20,000 AF or No Spill	1.5 cfs[1)]	Alisal Road Bridge[2)]
<30,000 AF	No Spill	Periodic Release; ≤30AF per month	Stilling Basin and Long Pool

1) When rainbow trout/steelhead are present in the Alisal Reach.
2) This target will be met in the year immediately following a year with spill >20,000 AF.
Source: Lower Santa Ynez River Fish Management Plan, October 2, 2000, pg. 3-9.

In years when Cachuma Reservoir spills 20,000 acre-feet or more, a target flow of 10 cfs will be maintained at the Highway 154 Bridge up to the capacity of Hilton Creek supplemental watering system of 10 cfs. In years when Cachuma Reservoir does not spill or spills less than 20,000 acre-feet, the Highway 154 target flow will be determined at the start of each month based on reservoir storage: 5.0 cfs when storage is greater than 120,000 acre-feet and 2.5 cfs when storage is less than 120,000 acre-feet. Periodic releases to refresh the Stilling Basin and Long Pool will be made when storage is less than 30,000 acre-feet. In addition, the BO requires a 2 cfs minimum flow in Hilton Creek once a pump is installed as a part of the terms and conditions to implement Reasonable and Prudent Measure No. 2. Also, both the BO and FMP under the final phase the USBR shall provide a target flow of 1.5 cfs at Alisal Road Bridge in years with spill greater than 20,000 acre-feet and the first year after such spill years if steelhead are present. In addition, under the final implementation phase of the BO and FMP, specific volumes of water are dedicated for the "Fish Passage Account" (3,200 acre-feet) and for the "Adaptive Management Account" (500 acre-feet) for a total of 3,700 acre-feet. This passage account water is released in months of January through May on top of naturally occurring storms. These fish flow operations (interim and final phase) were modeled using the SYRHM as was performed in preparation of the Biological Assessment, NOAA Fisheries Biological Opinion (BO), the Lower Santa Ynez River Fish Management Plan, the State Board Draft EIR (2003), and the Draft EIR/EIS (2003) on the Fish Management Plan and the BO (see references)

3.2 RESULTS OF MODEL SIMULATIONS

The primary model results of interest are the potential changes in water levels in the vicinity of the Solvang well field. The results in the vicinity of the Solvang well field were compiled at five cells considered to represent the average and maximum change in water level in that area. These locations are shown on Figure 4 with selected model cells marked with an X. The average and maximum water level declines from full aquifer conditions at these locations are presented in Table 11.

Under the first Scenario (GW1), which approximately represents current operations, the water levels in the vicinity of the Solvang well field decrease by an average of about one to three feet. During the driest period, water levels decline from 10 to 17 feet. These results are comparable to those for historical conditions. The declines are greatest in the upstream end of the Solvang well field due to the close proximity of ID No. 1's 6 cfs well field. Figure 15 shows the water level decline simulated for November 1990 conditions under Scenario GW1. This month had the largest drawdowns for the simulation period due to low stream flows in late 1990. The largest water level declines from a full aquifer condition occur in the vicinity of the ID No.1 6-cfs well field. The maximum drawdown of about 20 feet occurs near the 6-cfs well field.

Near the downstream boundary of the model, the drawdown during the entire simulation is minimal. At the upstream portion of the model area there is almost no drawdown since pumping is less in this area and any recharge available from the river flow occurs in this area first.

Under Scenario GW2 with Solvang pumping of 2,400 afy, the average water level decline at the same simulation output locations ranged from about four to seven feet, with a maximum range during the driest period of 28 to 35 feet. The wells would probably not be able to pump 2,400 afy under the pumping schedules shown in Tables 5 and 6 during very dry periods due to excessive drawdown in the pumping wells, which would cause pumps to break suction and pump air. Figure 16 shows the maximum simulated drawdown in November 1990 for Scenario GW2. It shows a wider extend of the maximum value of about 35 feet. The maximum drawdown near the downstream boundary of the model during this simulation is about five feet.

TABLE 11
SUMMARY OF SIMULATED GROUNDWATER LEVEL DRAWDOWN
AT SELECTED OBSERVATION POINTS WITHIN AND NEAR PROPOSED SOLVANG WELL FIELD, 1953-1993
(feet)

Ground Water Model Simulation	City of Solvang River Well Pumping afy	2500' Downstream of Solvang WF Center			1000' Downstream of Solvang WF Center			Solvang WF Center			1000' Upstream of Solvang WF Center			2000' Upstream of Solvang WF Center		
		Avg	Max	Max Mon-Yr	Avg	Max	Max Mon-Yr	Avg	Max	Max Mon-Yr	Avg	Max	Max Mon-Yr	Avg	Max	Max Mon-Yr
Solvang EIR GW1	600	1.1	10.2	Dec-90	2.3	13.5	Dec-90	2.0	14.4	Nov-90	2.3	15.5	Nov-90	2.8	17.2	Oct-90
Solvang EIR GW2	2,400	4.3	27.6	Dec-90	6.5	33.3	Dec-90	6.8	35.9	Nov-90	6.7	36.5	Nov-90	5.9	35.4	Nov-90
Solvang EIR GW3	3,600	7.0	41.3	Feb-91	10.0	dry	Feb-91	10.3	dry	Feb-91	10.0	dry	Feb-91	8.5	dry	Feb-91

dry = Groundwater level reached bottom of aquifer

The results of Scenario GW3, with Solvang pumping at 3,600 afy, indicate the average water level decline in the vicinity of the well field would range from seven to 10 feet. The maximum water level decline during dry periods is simulated as reaching to or below the bottom of the alluvial aquifer. Wells would cease to operate under these conditions before the lowest simulated groundwater levels are ever reached. Figure 17 shows the maximum simulated drawdown in February 1991 for Scenario GW3. The maximum drawdown near the downstream boundary of the model during this simulation is about eight feet, which was sufficient to slightly reverse the flow at this boundary for the three driest periods of the simulation.

Water level hydrographs for the selected cells in the vicinity of Solvang's wells are shown in Figures 18 through 22. These show that after even extreme dry periods, water levels recover the following winter. This response is due to resumption of Santa Ynez River flows and resulting recharge to the river alluvium. The water level declines of 30 feet or more only occur in Scenarios GW2 and GW3 during four periods; late 1961, late 1964 to early 1965, late 1977, and late 1990 to early 1991. The wells could not actually be operated at the simulated rates during those periods as noted above.

Water level hydrographs for selected USBR monitoring well sites, along with historical measured data, are shown in Figures 23 through 26. These show, as expected, a decreasing influence of Solvang and ID No. 6-cfs well field pumping with distance upstream from those wells. However, in the upstream areas the hydrographs for Scenario GW1 compared to those for GW2 and GW 3 have a different signature than those below, as seen in the hydrographs for USBR Wells -19Q2 and -21B2. The difference is due, in part to the River inflows for each scenario (Figure 14). Scenarios GW2 and GW3 have larger releases for fish from Cachuma Reservoir compared to GW1 (see Tables 9 and 10). For example, during non-spill years, fish flow targets in the Highway 154 management area are 2.5 to 5 cfs in scenarios GW2 and GW3 (final phase of fish flow operations) compares to 1.5 to 2.5 cfs in scenario GW 1 (interim phase of fish flow operations). Also notice that the well hydrograph for -21B2 is very stable (Figure 26) under both types of fish flow operation compared with historical conditions (Figure 10). This is due to the constant source of stream percolation provided by the releases for fish upstream.

The groundwater budgets for each scenario are presented in Tables 11, 12, and 13. The primary difference between the scenarios is the increase in Solvang River well pumping. This increase in pumping correlates directly with an increase net stream percolation. For

example, Tables 12, 13, and 14 show that average annual net stream flow loss increased from 4,379, 6,108, and 7,235 acre-feet per year for Scenarios GW1, GW2, and GW3, respectively.

Tables 12, 13, and 14 show that average annual storage did not change significantly because the additional stream percolation losses were able to balance the additional pumping on average. However, during dry years when there is none to little streamflow, groundwater storage change is significant. For example in water year 1991, net change in groundwater storage decreased from -2,238 to -3,889 and to -5,129 acre-feet for Scenarios GW1, GW2, and GW3, respectively. Other budget components, such as phreatophyte loss and subsurface outflow, did not change significantly on average primarily due to the quick recovery of water levels in the winter and during WR89-18 water rights releases.

TABLE 12

SUMMARY OF SIMULATED GROUNDWATER BUDGET - EIR SCENARIO GW1 (SOLVANG PUMPING 600 AFY)

ANNUAL MODEL BUDGET

	INFLOW					OUTFLOW									
Water Year	Storage (loss of gw in Storage)	Recharge af/y	Subsurface Upstream af/y	Subsurface Downstream af/y	Stream Loss to GW af/y	Storage (gain of gw in storage)	Ag Wells af/y	Solvang Wells af/y	ID Wells af/y	Total Pumping af/y	Phreatophyte Loss (ET) af/y	Subsurface Downstream af/y	Stream Gain from GW af/y	Net Change of GW in Storage	Net Stream Gain+/Loss-
1953	1,282	945	756	0	7,988	1,217	1,524	600	2,400	4,524	661	1,028	3,518	65	4,470
1954	856	818	756	0	8,468	853	1,591	600	2,400	4,591	677	1,028	3,703	3	4,765
1955	1,870	826	756	0	7,440	1,413	1,614	600	2,400	4,614	637	1,027	3,172	457	4,268
1956	1,710	855	758	0	8,163	2,169	1,522	600	2,400	4,522	642	1,028	3,137	-458	5,027
1957	1,272	848	756	0	7,133	1,045	1,538	600	2,400	4,538	651	1,026	2,765	227	4,368
1958	1,288	933	756	0	6,993	760	1,360	600	2,400	4,360	643	1,023	3,227	528	3,766
1959	1,346	933	756	0	8,189	2,100	1,620	600	2,400	4,619	618	1,013	2,848	-754	5,341
1960	1,746	806	758	0	7,461	1,235	1,563	600	2,400	4,563	635	1,024	3,281	511	4,180
1961	3,110	806	756	0	3,857	1,292	1,529	600	2,400	4,529	475	991	1,244	1,818	2,612
1962	1,519	871	756	0	8,492	3,422	1,466	600	2,399	4,464	601	977	2,176	-1,903	6,315
1963	1,664	879	756	0	7,273	1,593	1,567	600	2,401	4,568	637	1,019	2,764	71	4,509
1964	2,933	815	758	0	4,539	1,381	1,482	600	2,399	4,481	499	986	1,701	1,552	2,837
1965	1,407	812	756	0	7,631	3,112	1,419	600	2,401	4,421	550	983	1,550	-1,706	6,081
1966	1,733	831	756	0	8,095	2,077	1,407	600	2,399	4,406	627	1,024	3,267	-345	4,828
1967	670	882	756	0	8,028	427	1,268	600	2,401	4,269	691	1,028	3,898	243	4,130
1968	843	863	758	0	8,246	1,090	1,324	600	2,399	4,323	680	1,027	3,584	-248	4,663
1969	751	979	756	0	7,337	152	1,086	600	2,401	4,087	676	1,029	3,887	599	3,450
1970	1,003	979	756	0	8,039	1,600	1,311	600	2,399	4,310	646	1,020	3,184	-597	4,855
1971	638	806	756	0	8,336	640	1,348	600	2,399	4,346	682	1,028	3,767	-2	4,568
1972	1,022	806	758	0	8,248	1,019	1,338	600	2,401	4,340	680	1,030	3,703	2	4,545
1973	1,058	887	756	0	7,461	686	1,230	600	2,399	4,229	661	1,025	3,567	372	3,893
1974	1,329	896	756	0	8,150	1,685	1,371	600	2,401	4,372	652	1,024	3,432	-356	4,718
1975	1,651	883	756	0	6,676	755	1,205	600	2,399	4,204	645	1,026	3,359	895	3,317
1976	888	876	758	0	7,991	1,802	1,380	600	2,401	4,381	591	1,006	2,718	-914	5,273
1977	2,335	808	756	0	5,436	859	1,416	600	2,399	4,416	601	1,017	2,440	1,476	2,996
1978	1,010	1,005	756	0	7,938	2,089	1,189	600	2,399	4,188	637	1,012	2,835	-1,079	5,103
1979	1,240	1,042	756	0	7,399	1,150	1,389	600	2,401	4,390	640	1,028	3,271	90	4,128
1980	1,276	909	758	0	7,486	1,329	1,313	600	2,399	4,312	643	1,015	3,180	-53	4,307
1981	1,474	882	756	0	7,984	1,899	1,488	600	2,401	4,489	634	1,006	3,081	-425	4,904
1982	769	826	756	0	8,056	774	1,357	600	2,399	4,356	684	1,028	3,545	-5	4,511
1983	197	1,049	755	0	7,952	126	1,012	600	2,401	4,014	702	1,031	4,114	71	3,838
1984	735	1,040	758	0	8,356	803	1,442	600	2,399	4,441	683	1,033	3,884	-69	4,472
1985	1,632	806	758	0	7,805	1,632	1,364	600	2,399	4,363	613	1,022	3,310	0	4,495
1986	1,573	863	755	0	7,415	1,499	1,343	600	2,401	4,344	643	1,024	3,127	73	4,288
1987	2,006	865	755	0	6,382	1,492	1,286	600	2,399	4,285	607	1,015	2,608	514	3,774
1988	854	836	758	0	7,782	1,444	1,439	600	2,401	4,441	637	992	2,707	-590	5,076
1989	1,892	833	755	0	6,405	1,373	1,320	600	2,399	4,319	614	1,024	2,564	519	3,841
1990	2,736	806	755	0	3,696	1,017	1,286	600	2,401	4,287	448	962	1,306	1,719	2,390
1991	659	824	755	0	8,999	2,897	1,433	600	2,399	4,431	601	923	2,397	-2,238	6,602
1992	1,162	893	758	0	7,805	1,162	1,334	599	2,399	4,332	668	1,031	3,434	0	4,371
1993	631	1,024	755	0	7,599	126	1,212	601	2,401	4,215	686	1,028	3,949	505	3,650
53-93 avg	**1,360**	**882**	**756**	**0**	**7,432**	**1,346**	**1,383**	**600**	**2,400**	**4,383**	**632**	**1,015**	**3,054**	**14**	**4,379**
53-93 med	**1,282**	**865**	**756**	**0**	**7,805**	**1,292**	**1,371**	**600**	**2,400**	**4,372**	**642**	**1,024**	**3,184**	**3**	**4,470**
53-93 min	**197**	**806**	**755**	**0**	**3,696**	**126**	**1,012**	**599**	**2,399**	**4,014**	**448**	**923**	**1,244**	**-2,238**	**2,390**
53-93 max	**3,110**	**1,049**	**758**	**0**	**8,999**	**3,422**	**1,620**	**601**	**2,401**	**4,619**	**702**	**1,033**	**4,114**	**1,818**	**6,602**

AVERAGE MONTHLY MODEL BUDGET

	INFLOW					OUTFLOW									
Month	Storage (loss of gw in Storage)	Recharge af/m	Subsurface Upstream af/m	Subsurface Downstream af/m	Stream Loss to GW af/m	Storage (gain of gw in storage)	Ag Wells af/m	Solvang Wells af/m	ID Wells af/m	Total Pumping af/m	Phreatophyte Loss (ET) af/m	Subsurface Downstream af/m	Stream Gain from GW af/m	Net Change of GW in Storage	Net Stream Gain+/Loss-
Oct	181	69	64	0	506	28	120	53	259	432	44	86	227	153	279
Nov	69	75	62	0	438	66	22	49	158	230	26	82	236	3	202
Dec	23	78	64	0	443	81	1	45	110	156	20	85	264	-58	179
Jan	5	83	64	0	568	180	0	37	91	129	21	85	302	-175	265
Feb	5	85	59	0	535	158	0	17	79	97	30	79	318	-153	217
Mar	57	82	64	0	615	82	13	29	230	273	48	87	331	-26	284
Apr	90	72	62	0	588	46	41	44	250	335	68	84	288	44	300
May	158	68	64	0	654	100	122	50	254	427	77	87	257	58	396
Jun	231	67	62	0	651	100	258	65	216	539	80	84	209	131	442
Jul	226	67	64	0	847	213	331	64	233	628	82	87	196	14	651
Aug	155	67	64	0	906	193	278	72	276	626	78	86	208	-38	698
Sep	160	69	62	0	683	100	196	73	242	511	57	83	217	60	466
avg anl	**1,360**	**882**	**756**	**0**	**7,432**	**1,346**	**1,383**	**600**	**2,400**	**4,383**	**632**	**1,015**	**3,054**	**14**	**4,379**

TABLE 13

SUMMARY OF SIMULATED GROUNDWATER BUDGET - EIR SCENARIO GW 2 (SOLVANG PUMPING 2,400 AFY)

ANNUAL MODEL BUDGET

	INFLOW					OUTFLOW									
Water Year	Storage (loss of gw in Storage)	Recharge af/y	Subsurface Upstream af/y	Subsurface Downstream af/y	Stream Loss to GW af/y	Storage (gain of gw in storage)	Ag Wells af/y	Solvang Wells af/y	ID Wells af/y	Total Pumping af/y	Phreatophyte Loss (ET) af/y	Subsurface Downstream af/y	Stream Gain from GW af/y	Net Change of Groundwater in Storage	Net Stream Gain+/Loss-
1953	1,057	945	756	0	9,883	973	1,524	2,400	2,400	6,324	673	1,026	3,615	84	6,269
1954	1,044	818	756	0	10,044	1,042	1,591	2,400	2,400	6,391	675	1,025	3,514	2	6,530
1955	2,599	826	756	0	8,722	1,938	1,614	2,400	2,400	6,413	611	1,019	2,912	662	5,810
1956	2,734	855	758	0	9,481	2,912	1,522	2,400	2,400	6,322	613	1,016	2,978	-178	6,503
1957	2,063	848	756	0	8,770	1,963	1,538	2,400	2,400	6,338	584	948	2,603	100	6,166
1958	1,419	933	756	0	9,277	1,520	1,360	2,400	2,400	6,160	646	1,000	3,090	-100	6,187
1959	1,177	933	756	0	10,225	1,662	1,620	2,400	2,400	6,420	661	976	3,359	-485	6,866
1960	2,003	806	758	0	8,407	599	1,563	2,400	2,400	6,362	630	1,000	3,350	1,404	5,057
1961	3,910	806	756	0	4,977	1,406	1,529	2,400	2,400	6,329	400	607	1,713	2,503	3,264
1962	1,757	871	756	0	11,628	5,177	1,466	2,399	2,399	6,264	596	773	2,204	-3,420	9,424
1963	2,323	879	756	0	8,974	1,810	1,567	2,401	2,401	6,369	627	994	3,145	513	5,829
1964	3,701	815	758	0	6,267	1,683	1,482	2,399	2,399	6,280	475	747	2,355	2,018	3,912
1965	2,339	812	756	0	9,761	4,511	1,419	2,401	2,401	6,222	509	736	1,697	-2,172	8,065
1966	1,853	831	756	0	10,390	2,702	1,407	2,399	2,399	6,205	626	1,015	3,271	-849	7,119
1967	347	882	756	0	9,943	351	1,268	2,401	2,401	6,070	698	1,028	3,749	-5	6,194
1968	769	863	758	0	9,814	767	1,324	2,399	2,399	6,122	690	1,023	3,600	2	6,214
1969	514	979	756	0	9,291	154	1,086	2,401	2,401	5,888	692	1,027	3,788	360	5,503
1970	1,141	979	756	0	9,867	1,499	1,311	2,399	2,399	6,109	665	992	3,460	-358	6,407
1971	565	806	756	0	10,046	567	1,348	2,399	2,399	6,146	690	1,027	3,678	-2	6,368
1972	994	806	758	0	9,945	994	1,338	2,401	2,401	6,141	682	1,029	3,602	0	6,343
1973	1,003	887	756	0	9,238	618	1,230	2,399	2,399	6,028	682	1,022	3,551	386	5,686
1974	1,536	896	756	0	9,798	1,908	1,371	2,401	2,401	6,173	644	974	3,308	-372	6,490
1975	2,107	883	756	0	8,042	774	1,205	2,399	2,399	6,003	631	1,018	3,388	1,334	4,653
1976	2,080	876	758	0	10,071	2,968	1,380	2,401	2,401	6,182	610	916	3,108	-888	6,963
1977	3,053	808	756	0	7,121	1,309	1,416	2,399	2,399	6,214	572	919	2,727	1,745	4,394
1978	1,132	1,005	756	0	10,675	3,127	1,189	2,399	2,399	5,987	637	955	2,911	-1,995	7,764
1979	955	1,042	756	0	9,389	735	1,389	2,401	2,401	6,191	677	1,012	3,558	220	5,831
1980	870	909	758	0	9,504	790	1,313	2,399	2,399	6,111	678	985	3,522	80	5,983
1981	1,547	882	756	0	9,940	2,045	1,488	2,401	2,401	6,290	638	960	3,230	-498	6,710
1982	845	826	756	0	9,871	854	1,357	2,399	2,399	6,155	685	1,024	3,563	-9	6,309
1983	455	1,049	755	0	9,504	466	1,012	2,399	2,401	5,813	696	1,028	3,815	-11	5,689
1984	1,908	1,040	758	0	9,343	1,713	1,442	2,401	2,399	6,242	617	1,012	3,464	195	5,879
1985	1,793	806	758	0	9,665	1,977	1,364	2,399	2,399	6,162	629	989	3,278	-184	6,387
1986	2,073	863	755	0	8,976	1,637	1,343	2,401	2,401	6,146	631	1,006	3,287	436	5,689
1987	2,268	865	755	0	8,104	1,299	1,286	2,399	2,399	6,084	606	895	3,097	969	5,007
1988	863	836	758	0	10,767	2,268	1,439	2,399	2,401	6,240	646	849	3,225	-1,405	7,541
1989	2,835	833	755	0	7,392	1,641	1,320	2,401	2,399	6,120	588	969	2,493	1,194	4,899
1990	3,790	806	755	0	4,706	1,095	1,286	2,399	2,401	6,086	386	716	1,800	2,695	2,906
1991	1,022	824	755	0	12,098	4,910	1,433	2,401	2,399	6,233	590	686	2,264	-3,889	9,835
1992	1,568	893	758	0	9,435	1,568	1,334	2,399	2,399	6,132	659	1,022	3,297	0	6,139
1993	443	1,024	755	0	9,458	133	1,212	2,401	2,401	6,015	696	1,028	3,799	310	5,659
53-93 avg	**1,670**	**882**	**756**	**0**	**9,239**	**1,660**	**1,383**	**2,400**	**2,400**	**6,183**	**625**	**951**	**3,131**	**10**	**6,108**
53-93 med	**1,547**	**865**	**756**	**0**	**9,504**	**1,520**	**1,371**	**2,400**	**2,400**	**6,173**	**637**	**1,000**	**3,287**	**2**	**6,187**
53-93 min	**347**	**806**	**755**	**0**	**4,706**	**133**	**1,012**	**2,399**	**2,399**	**5,813**	**386**	**607**	**1,697**	**-3,889**	**2,906**
53-93 max	**3,910**	**1,049**	**758**	**0**	**12,098**	**5,177**	**1,620**	**2,401**	**2,401**	**6,420**	**698**	**1,029**	**3,815**	**2,695**	**9,835**

AVERAGE MONTHLY MODEL BUDGET

	INFLOW					OUTFLOW									
Month	Storage (loss of gw in Storage)	Recharge af/y	Subsurface Upstream af/y	Subsurface Downstream af/y	Stream Loss to GW af/y	Storage (gain of gw in storage)	Ag Wells af/y	Solvang Wells af/y	ID Wells af/y	Total Pumping af/y	Phreatophyte Loss (ET) af/y	Subsurface Downstream af/y	Stream Gain from GW af/y	Net Change of Groundwater in Storage	Net Stream Gain+/Loss-
Oct	226	69	64	0	608	26	120	211	259	591	43	80	227	201	381
Nov	111	75	62	0	582	96	22	196	158	376	26	75	253	15	328
Dec	49	78	64	0	616	125	1	182	110	293	20	76	289	-76	326
Jan	14	83	64	0	720	222	0	151	91	242	21	76	318	-207	402
Feb	8	85	59	0	664	247	0	70	79	149	29	71	317	-239	347
Mar	50	82	64	0	764	149	13	117	230	361	47	82	326	-99	438
Apr	92	72	62	0	735	61	41	178	250	468	67	81	291	31	444
May	174	68	64	0	831	130	122	202	254	579	77	84	269	44	562
Jun	281	67	62	0	797	102	258	259	216	733	80	81	215	179	582
Jul	247	67	64	0	983	180	331	253	233	817	81	84	201	67	782
Aug	202	67	64	0	1,093	213	278	288	276	842	77	83	211	-11	882
Sep	216	69	62	0	848	110	196	293	242	731	56	79	214	106	634
avg anl	**1,670**	**882**	**756**	**0**	**9,239**	**1,660**	**1,383**	**2,400**	**2,400**	**6,183**	**625**	**951**	**3,131**	**10**	**6,108**

TABLE 14
SUMMARY OF SIMULATED GROUNDWATER BUDGET - EIR SCENARIO GW3 (SOLVANG PUMPING 3,600 AFY)

ANNUAL MODEL BUDGET

	INFLOW					OUTFLOW									
Water Year	Storage (loss of gw in Storage)	Recharge af/y	Subsurface Upstream af/y	Subsurface Downstream af/y	Stream Loss to GW af/y	Storage (gain of gw in storage)	Ag Wells af/y	Solvang Wells af/y	ID Wells af/y	Total Pumping af/y	Phreatophyte Loss (ET) af/y	Subsurface Downstream af/y	Stream Gain from GW af/y	Net Change of GW in Storage	Net Stream Gain+/Loss-
1953	1,665	945	756	0	10,885	1,581	1,524	3,600	2,400	7,524	656	1,021	3,456	84	7,430
1954	1,358	818	756	0	11,145	1,355	1,591	3,600	2,400	7,591	669	1,022	3,424	3	7,721
1955	3,230	826	756	0	9,655	2,562	1,614	3,600	2,400	7,614	574	950	2,759	668	6,896
1956	3,027	855	758	0	10,441	2,990	1,522	3,600	2,400	7,522	613	1,013	2,940	37	7,501
1957	2,784	848	756	0	9,945	2,896	1,538	3,600	2,400	7,538	556	871	2,469	-111	7,476
1958	1,774	933	756	0	10,535	1,999	1,360	3,600	2,400	7,360	642	991	3,030	-225	7,505
1959	1,551	933	756	0	11,230	1,921	1,620	3,600	2,400	7,619	653	964	3,294	-370	7,937
1960	3,233	806	758	0	8,930	1,551	1,563	3,600	2,400	7,562	601	966	3,038	1,682	5,892
1961	4,887	806	756	0	4,796	1,372	1,529	3,600	2,400	7,528	364	447	1,543	3,515	3,253
1962	1,811	871	756	14	13,717	6,273	1,466	3,602	2,399	7,466	594	659	2,179	-4,461	11,538
1963	2,899	879	756	0	10,057	2,486	1,567	3,600	2,401	7,568	607	952	2,982	413	7,075
1964	4,704	815	758	0	5,810	1,455	1,482	3,600	2,399	7,481	417	556	2,183	3,248	3,627
1965	2,874	812	756	4	11,919	6,570	1,419	3,600	2,401	7,420	486	389	1,508	-3,696	10,411
1966	1,733	831	756	0	11,469	2,438	1,407	3,600	2,399	7,406	643	1,010	3,281	-705	8,189
1967	381	882	756	0	11,067	386	1,268	3,600	2,401	7,269	697	1,028	3,680	-5	7,388
1968	1,664	863	758	0	10,746	1,662	1,324	3,602	2,399	7,325	671	1,009	3,361	2	7,385
1969	670	979	756	0	10,321	246	1,086	3,600	2,401	7,087	688	1,026	3,694	425	6,628
1970	1,462	979	756	0	10,985	1,887	1,311	3,600	2,399	7,309	654	958	3,354	-425	7,631
1971	891	806	756	0	11,116	891	1,348	3,600	2,399	7,346	679	1,023	3,561	0	7,555
1972	1,488	806	758	0	10,994	1,488	1,338	3,600	2,401	7,339	674	1,027	3,469	0	7,525
1973	2,144	887	756	0	9,885	1,490	1,230	3,600	2,399	7,229	635	1,016	3,313	654	6,573
1974	2,167	896	756	0	11,113	2,815	1,371	3,600	2,401	7,371	628	941	3,198	-647	7,916
1975	2,351	883	756	0	9,118	960	1,205	3,602	2,399	7,206	626	1,016	3,324	1,391	5,794
1976	2,658	876	758	0	11,088	3,581	1,380	3,600	2,401	7,381	598	846	2,980	-923	8,108
1977	3,988	808	756	0	7,438	1,699	1,416	3,600	2,399	7,415	528	730	2,624	2,289	4,814
1978	1,405	1,005	756	0	12,236	3,926	1,189	3,600	2,399	7,188	632	884	2,812	-2,521	9,424
1979	1,171	1,042	756	0	10,399	877	1,389	3,600	2,401	7,390	671	1,006	3,473	294	6,926
1980	1,008	909	758	0	10,836	1,150	1,313	3,600	2,399	7,312	674	964	3,446	-142	7,390
1981	1,795	882	756	0	10,950	2,181	1,488	3,600	2,401	7,489	636	932	3,163	-386	7,787
1982	1,173	826	756	0	10,904	1,180	1,357	3,600	2,399	7,355	677	1,012	3,398	-7	7,507
1983	601	1,049	755	0	10,629	608	1,012	3,602	2,401	7,016	694	1,028	3,742	-7	6,887
1984	2,039	1,040	758	0	10,445	1,871	1,442	3,600	2,399	7,440	615	1,001	3,382	168	7,064
1985	2,165	806	758	0	10,354	2,130	1,364	3,600	2,399	7,362	617	893	3,062	34	7,291
1986	2,284	863	755	0	9,894	1,697	1,343	3,600	2,401	7,344	625	976	3,177	588	6,717
1987	3,120	865	755	0	9,206	2,369	1,286	3,600	2,399	7,284	582	799	2,922	751	6,283
1988	1,458	836	758	0	11,915	2,989	1,439	3,600	2,401	7,440	631	790	3,088	-1,531	8,827
1989	3,997	833	755	0	8,035	2,518	1,320	3,600	2,399	7,319	565	872	2,371	1,478	5,663
1990	4,692	806	755	0	4,637	1,042	1,286	3,600	2,401	7,287	362	487	1,719	3,650	2,918
1991	1,556	824	755	43	14,256	6,685	1,433	3,600	2,399	7,431	579	546	2,199	-5,129	12,057
1992	2,002	893	758	0	10,560	2,004	1,334	3,600	2,399	7,332	650	1,012	3,216	-2	7,344
1993	517	1,024	755	0	10,491	154	1,212	3,600	2,401	7,213	693	1,028	3,717	363	6,775
53-93 avg	**2,156**	**882**	**756**	**1**	**10,248**	**2,145**	**1,383**	**3,600**	**2,400**	**7,382**	**611**	**894**	**3,013**	**11**	**7,235**
53-93 med	**1,811**	**865**	**756**	**0**	**10,560**	**1,871**	**1,371**	**3,600**	**2,400**	**7,371**	**631**	**964**	**3,177**	**2**	**7,388**
53-93 min	**381**	**806**	**755**	**0**	**4,637**	**154**	**1,012**	**3,600**	**2,399**	**7,016**	**362**	**389**	**1,508**	**-5,129**	**2,918**
53-93 max	**4,887**	**1,049**	**758**	**43**	**14,256**	**6,685**	**1,620**	**3,602**	**2,401**	**7,619**	**697**	**1,028**	**3,742**	**3,650**	**12,057**

AVERAGE MONTHLY MODEL BUDGET

	INFLOW					OUTFLOW									
Month	Storage (loss of gw in Storage)	Recharge af/m	Subsurface Upstream af/m	Subsurface Downstream af/m	Stream Loss to GW af/m	Storage (gain of gw in storage)	Ag Wells af/m	Solvang Wells af/m	ID Wells af/m	Total Pumping af/m	Phreatophyte Loss (ET) af/m	Subsurface Downstream af/m	Stream Gain from GW af/m	Net Change of GW in Storage	Net Stream Gain+/Loss-
Oct	299	69	64	0	617	23	120	306	259	685	42	76	221	276	396
Nov	181	75	62	0	596	91	22	296	158	476	25	72	247	90	349
Dec	112	78	64	0	657	120	1	306	110	417	20	71	282	-8	375
Jan	50	83	64	0	841	244	0	306	91	397	20	70	305	-195	536
Feb	31	85	59	0	925	352	0	276	79	355	28	66	297	-320	628
Mar	96	82	64	0	968	234	13	306	230	549	46	76	308	-138	660
Apr	135	72	62	0	813	81	41	296	250	586	66	76	278	54	535
May	233	68	64	0	898	173	122	306	254	682	75	79	260	61	638
Jun	299	67	62	0	901	198	258	296	216	770	77	76	208	100	693
Jul	267	67	64	0	1,121	295	331	306	233	870	80	79	197	-28	924
Aug	231	67	64	0	1,078	223	278	306	276	860	76	78	204	8	874
Sep	221	69	62	0	833	111	196	296	242	734	55	75	206	111	627
avg anl	**2,156**	**882**	**756**	**1**	**10,248**	**2,145**	**1,383**	**3,600**	**2,400**	**7,382**	**611**	**894**	**3,013**	**11**	**7,235**

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FIGURE 1a

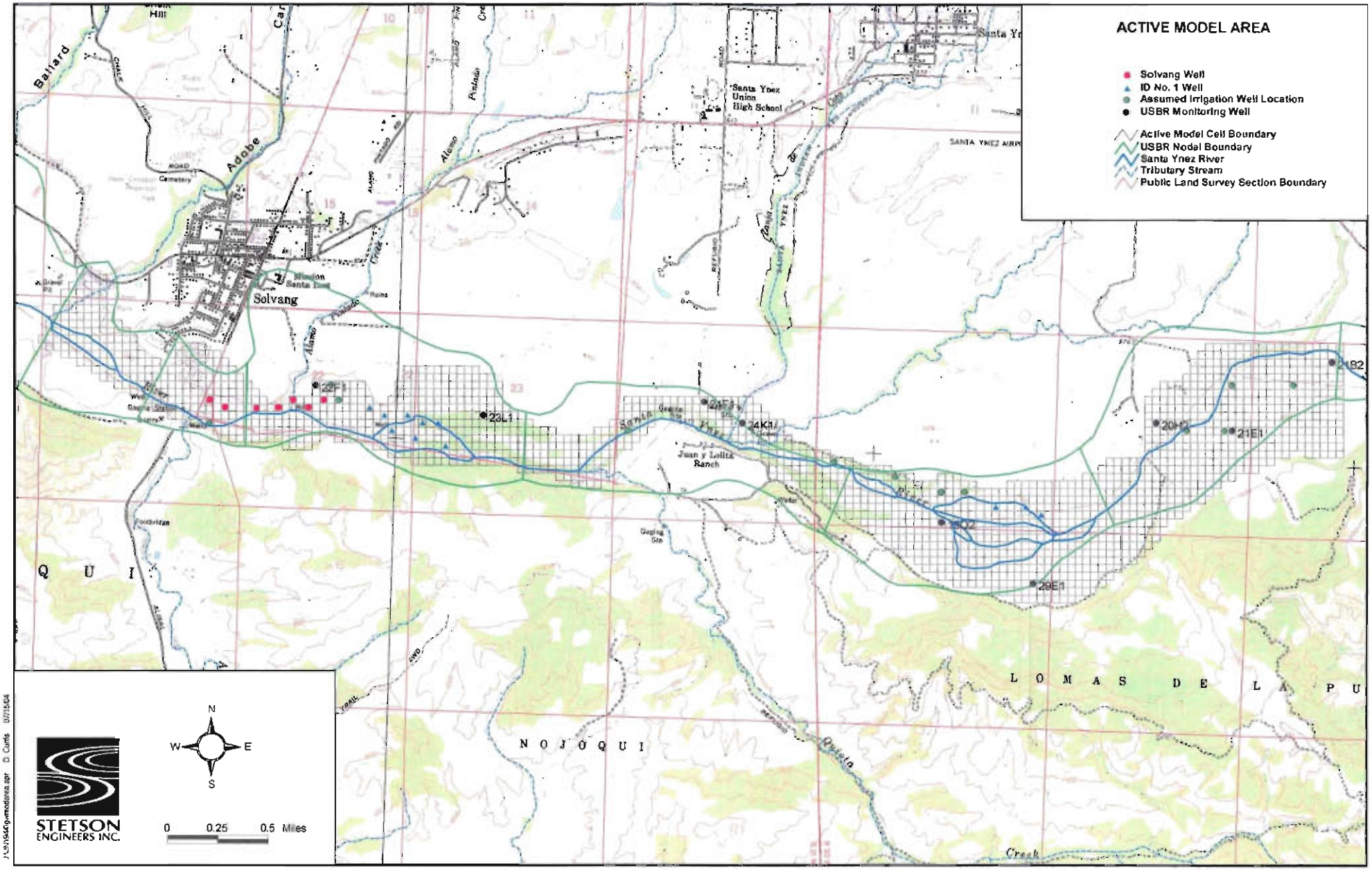

ACTIVE MODEL AREA
Solvang Well
ID No. 1 Well
Assumed Irrigation Well Location
USBR Monitoring Well
Active Model Cell Boundary
USBR Nodal Boundary
Santa Ynez River
Tributary Stream
Public Land Survey Section Boundary
Solvang
Santa Ynez Union High School
Juan y Lolita Ranch
Ballard
Adobe
Alamo
22F1
23L1
24K1
20H2
21E1
29E1
L O M A S D E L A P U
N O J O Q U I
Q U I
N
S
E
W
0 0.25 0.5 Miles
STETSON ENGINEERS INC.

FIGURE 1b

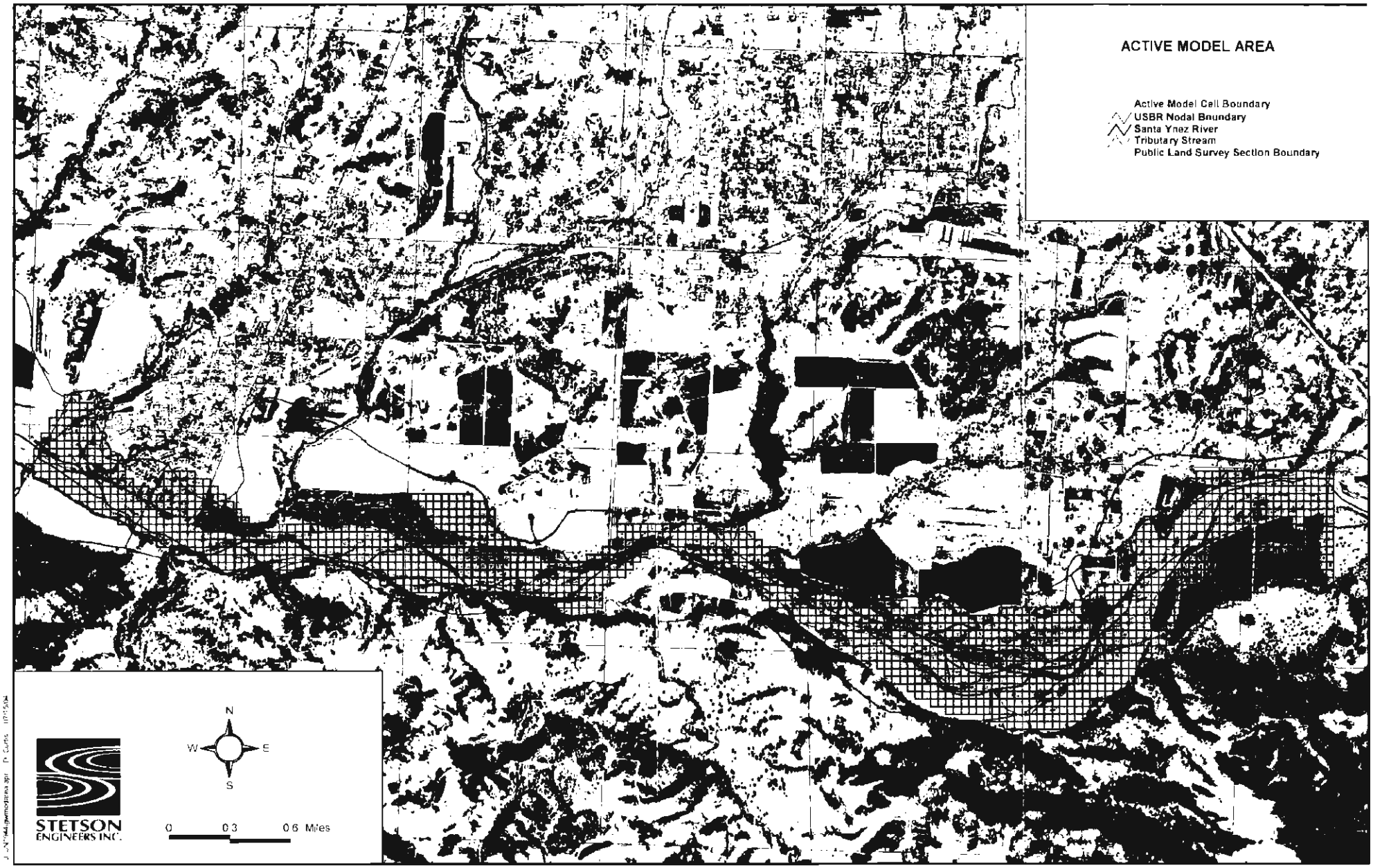
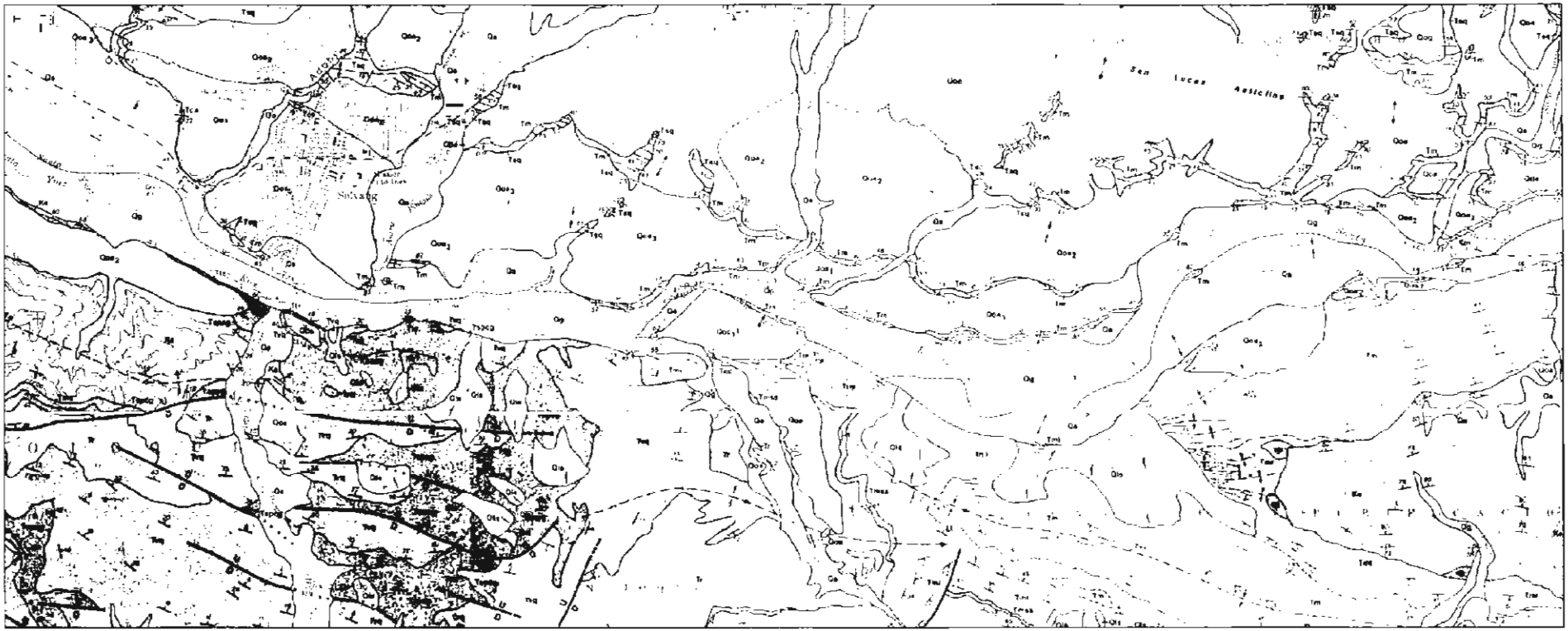
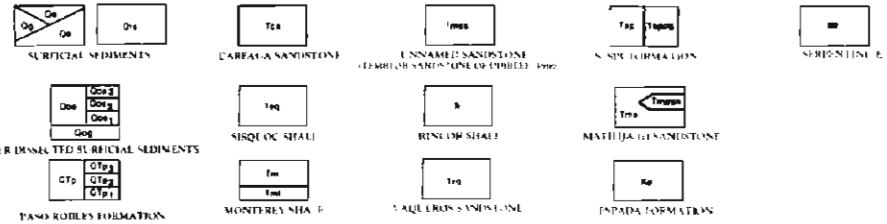

ACTIVE MODEL AREA
Active Model Cell Boundary
USBR Nodal Boundary
Santa Ynez River
Tributary Stream
Public Land Survey Section Boundary
N
W
E
S
0
0.3
0.6 Miles
STETSON
ENGINEERS INC.

FIGURE 2



LEGEND



(after Dibblee, 1988 a, b)

STETSON

Geologic Map

FIGURE 3

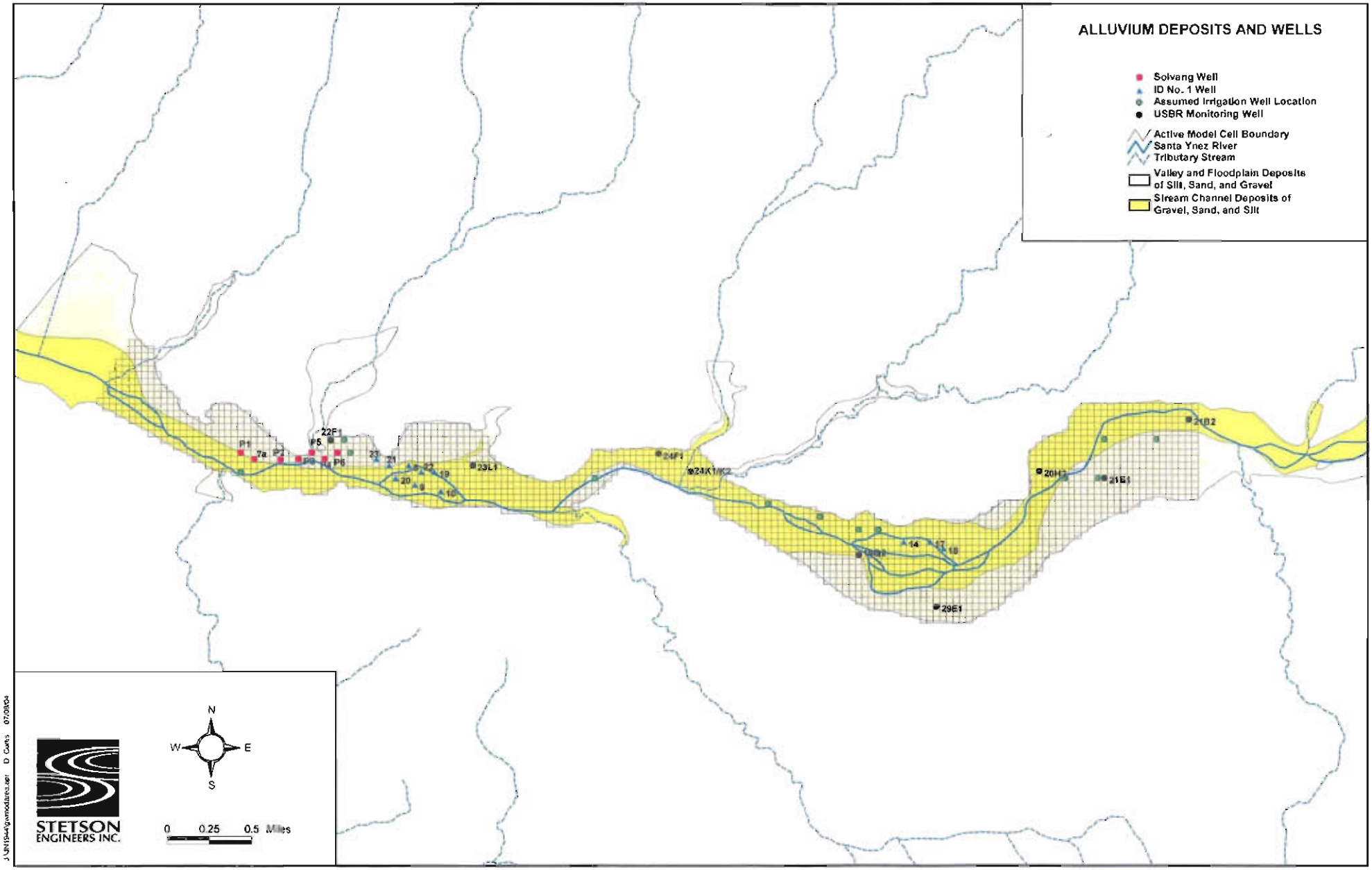

ALLUVIUM DEPOSITS AND WELLS
Solvang Well
ID No. 1 Well
Assumed Irrigation Well Location
USBR Monitoring Well
Active Model Cell Boundary
Santa Ynez River
Tributary Stream
Valley and Floodplain Deposits of Silt, Sand, and Gravel
Stream Channel Deposits of Gravel, Sand, and Silt
P1
7a
P2
P5
22F1
P6
23
21
22
19
20
16
23L1
24F1
24K1/K2
20H2
21E1
21D2
14
17
18
29E1
N
W
E
S
0
0.25
0.5 Miles
STETSON ENGINEERS INC.

FIGURE 4

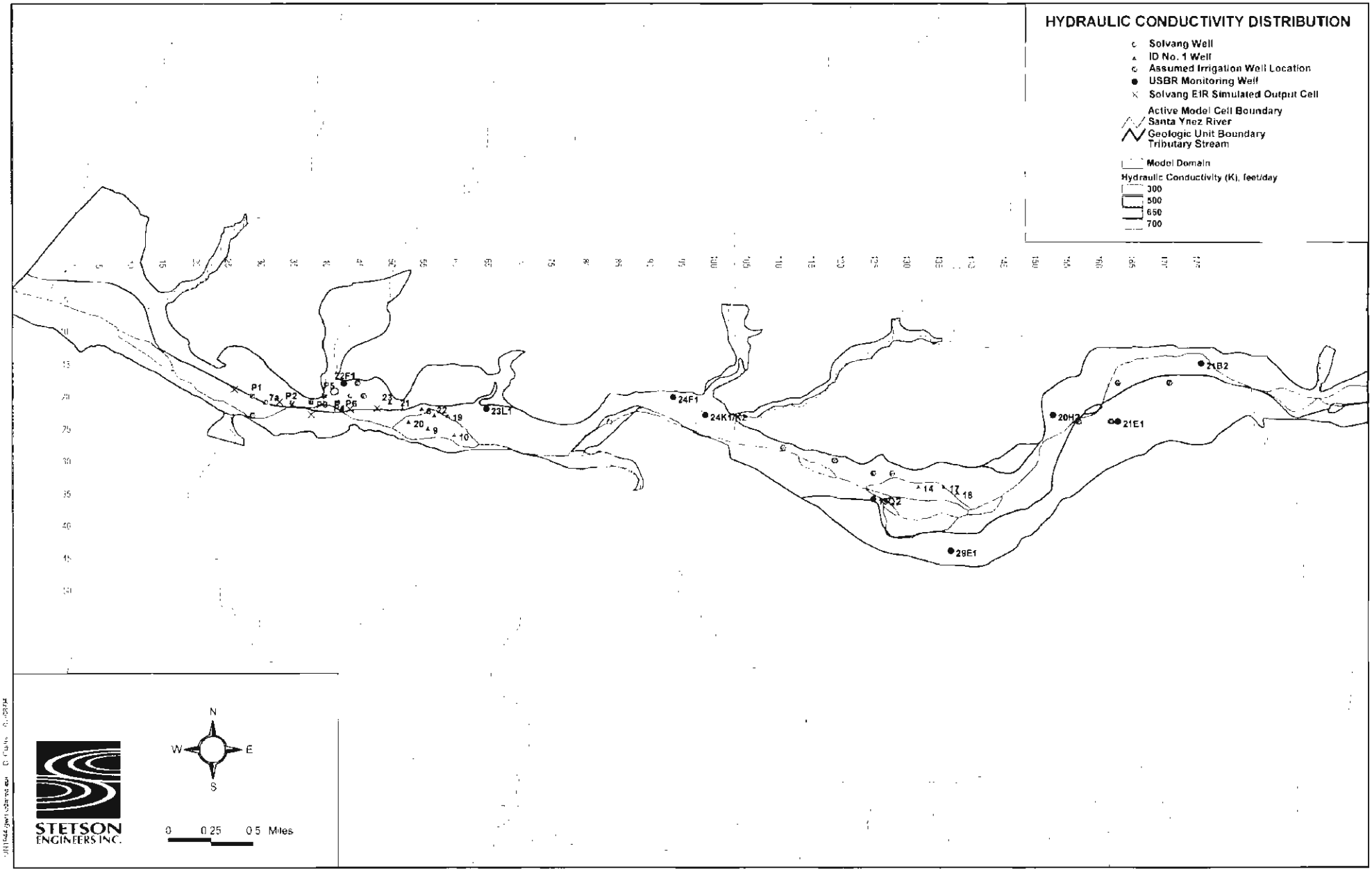
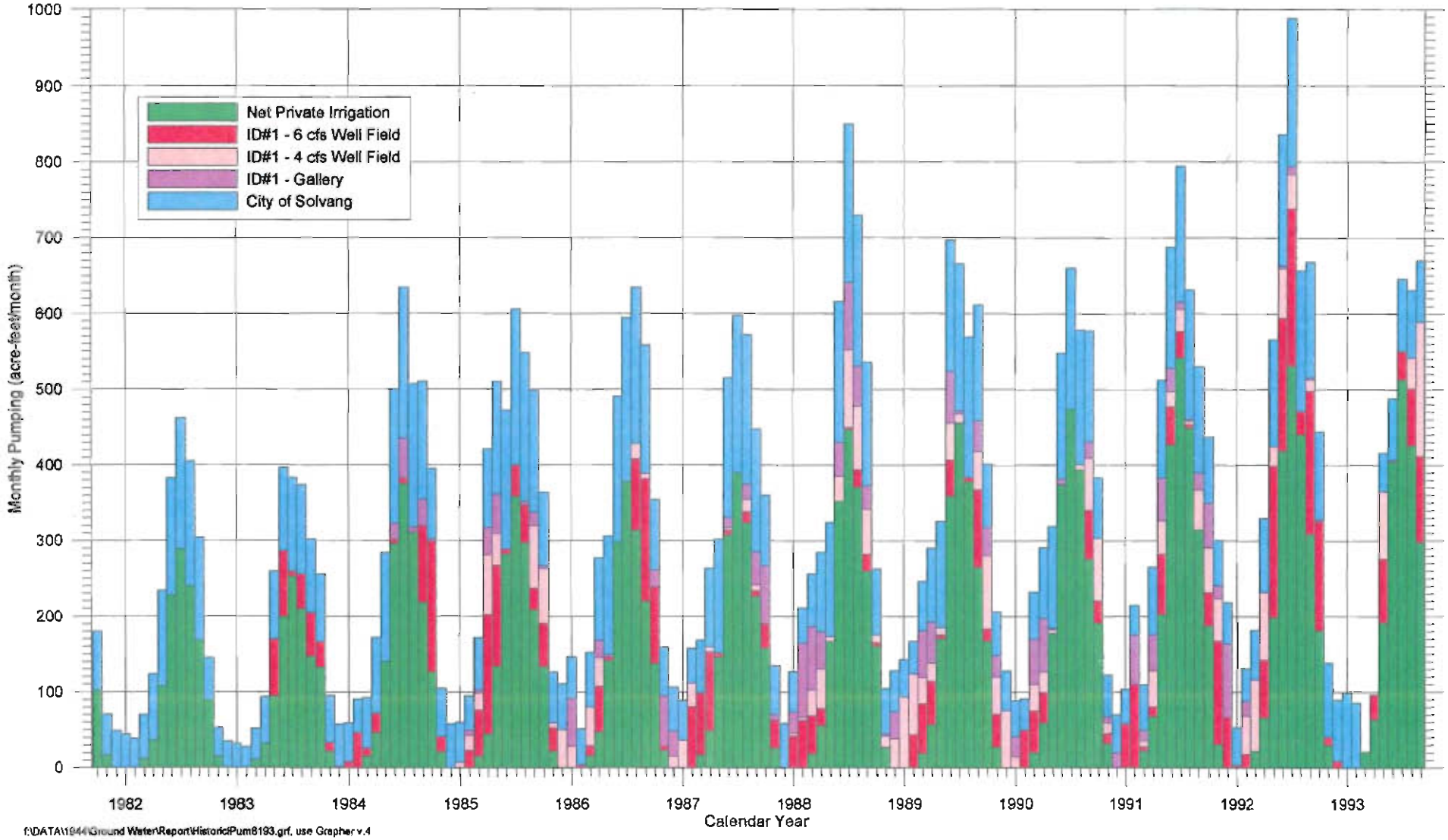

HYDRAULIC CONDUCTIVITY DISTRIBUTION
Solvang Well
ID No. 1 Well
Assumed Irrigation Well Location
USBR Monitoring Well
Solvang EIR Simulated Output Cell
Active Model Cell Boundary
Santa Ynez River
Geologic Unit Boundary
Tributary Stream
Model Domain
Hydraulic Conductivity (K), feet/day
300
500
650
700
P1
P2
P5
P6
22F1
23L1
24F1
24K1
20H2
21E1
21B2
29E1
N
W
E
S
0
0.25
0.5 Miles
STETSON ENGINEERS INC.

Figure 5

Monthly Pumping
October 1981 - September 1993
Santa Ynez River-Solvang/ID No. 1 GW model



f:\DATA\1944\Ground Water\Report\Historic\Pum8193.grf, use Grapher v.4

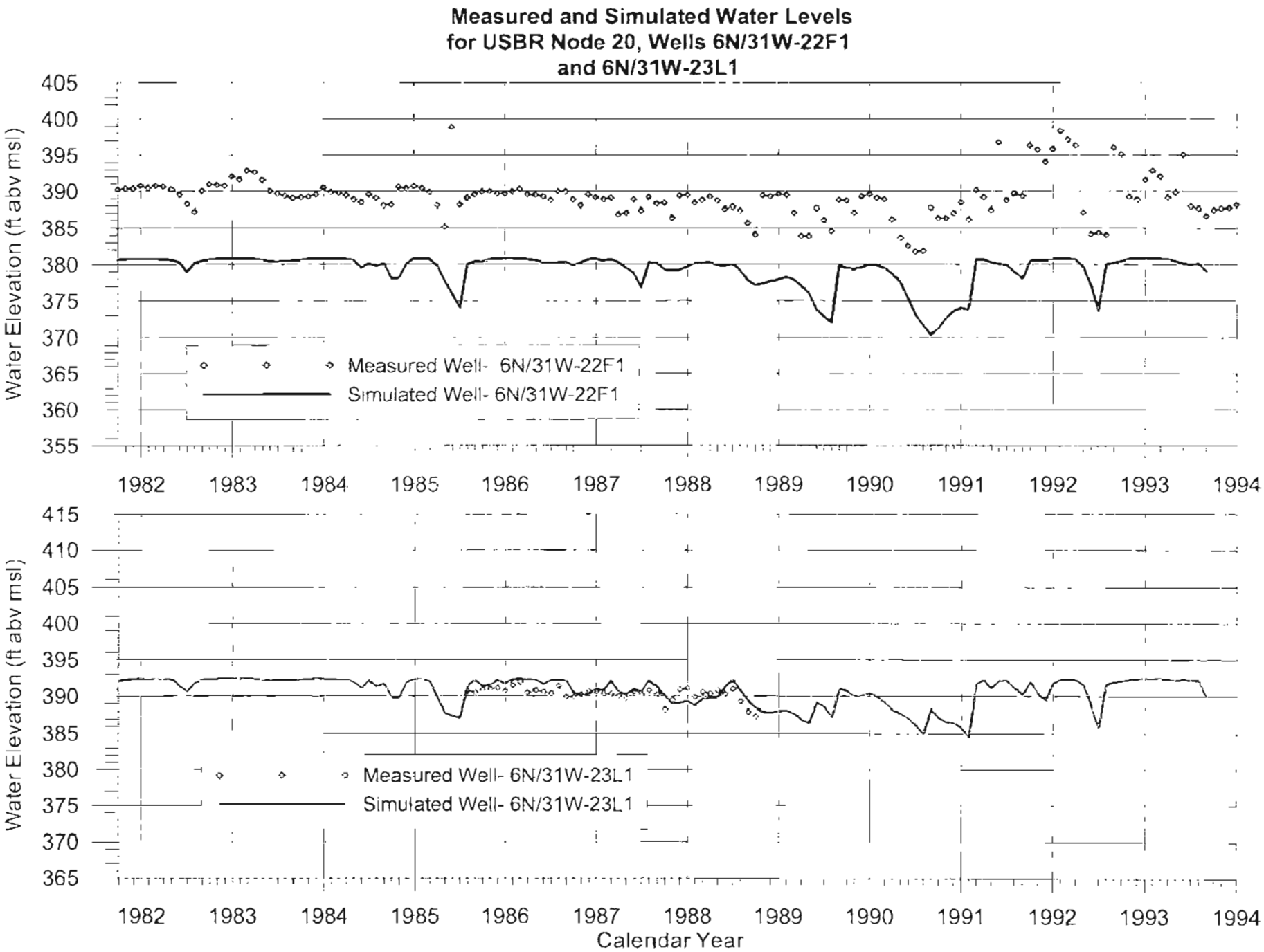

Measured and Simulated Water Levels
for USBR Node 20, Wells 6N/31W-22F1
and 6N/31W-23L1
Water Elevation (ft abv msl)
405
400
395
390
385
380
375
370
365
360
355
Measured Well- 6N/31W-22F1
Simulated Well- 6N/31W-22F1
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
415
410
405
400
395
390
385
380
375
370
365
Measured Well- 6N/31W-23L1
Simulated Well- 6N/31W-23L1
Calendar Year

Figure 6

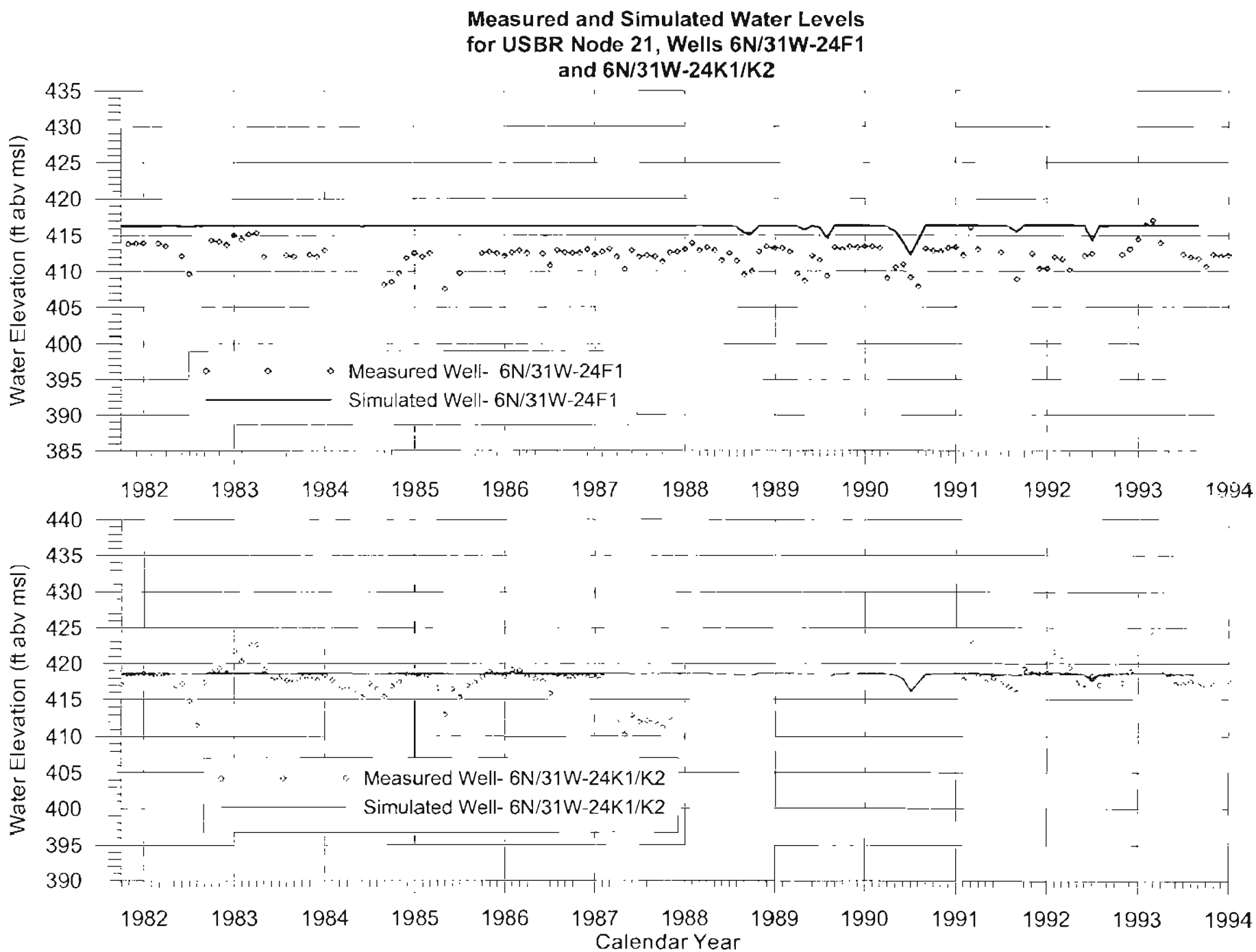

Measured and Simulated Water Levels
for USBR Node 21, Wells 6N/31W-24F1
and 6N/31W-24K1/K2
Water Elevation (ft abv msl)
435
430
425
420
415
410
405
400
395
390
385
Measured Well- 6N/31W-24F1
Simulated Well- 6N/31W-24F1
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Water Elevation (ft abv msl)
440
435
430
425
420
415
410
405
400
395
390
Measured Well- 6N/31W-24K1/K2
Simulated Well- 6N/31W-24K1/K2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Calendar Year

Figure 7

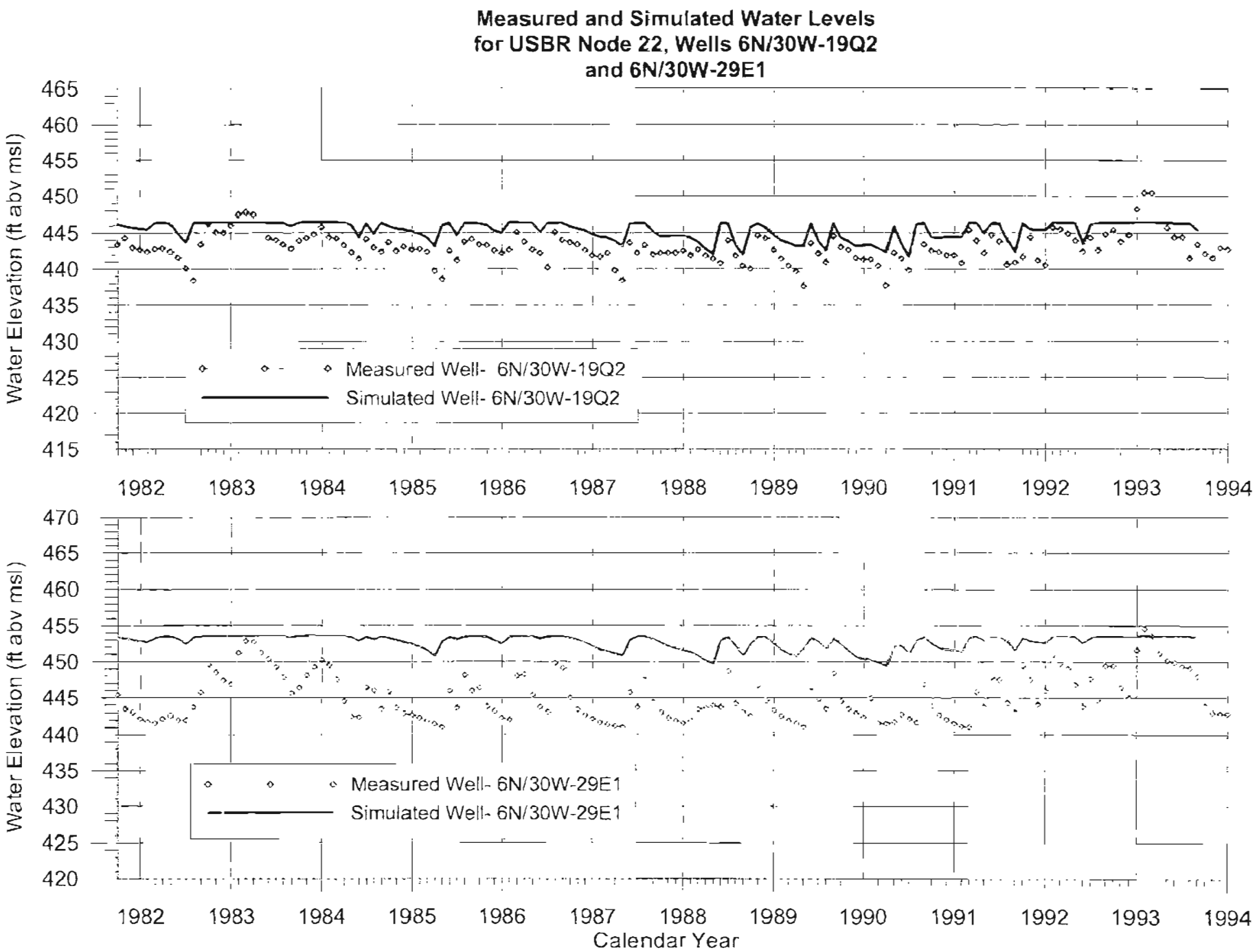

Measured and Simulated Water Levels
for USBR Node 22, Wells 6N/30W-19Q2
and 6N/30W-29E1
Water Elevation (ft abv msl)
465
460
455
450
445
440
435
430
425
420
415
Measured Well- 6N/30W-19Q2
Simulated Well- 6N/30W-19Q2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
470
465
460
455
450
445
440
435
430
425
420
Measured Well- 6N/30W-29E1
Simulated Well- 6N/30W-29E1
Calendar Year

Figure 8

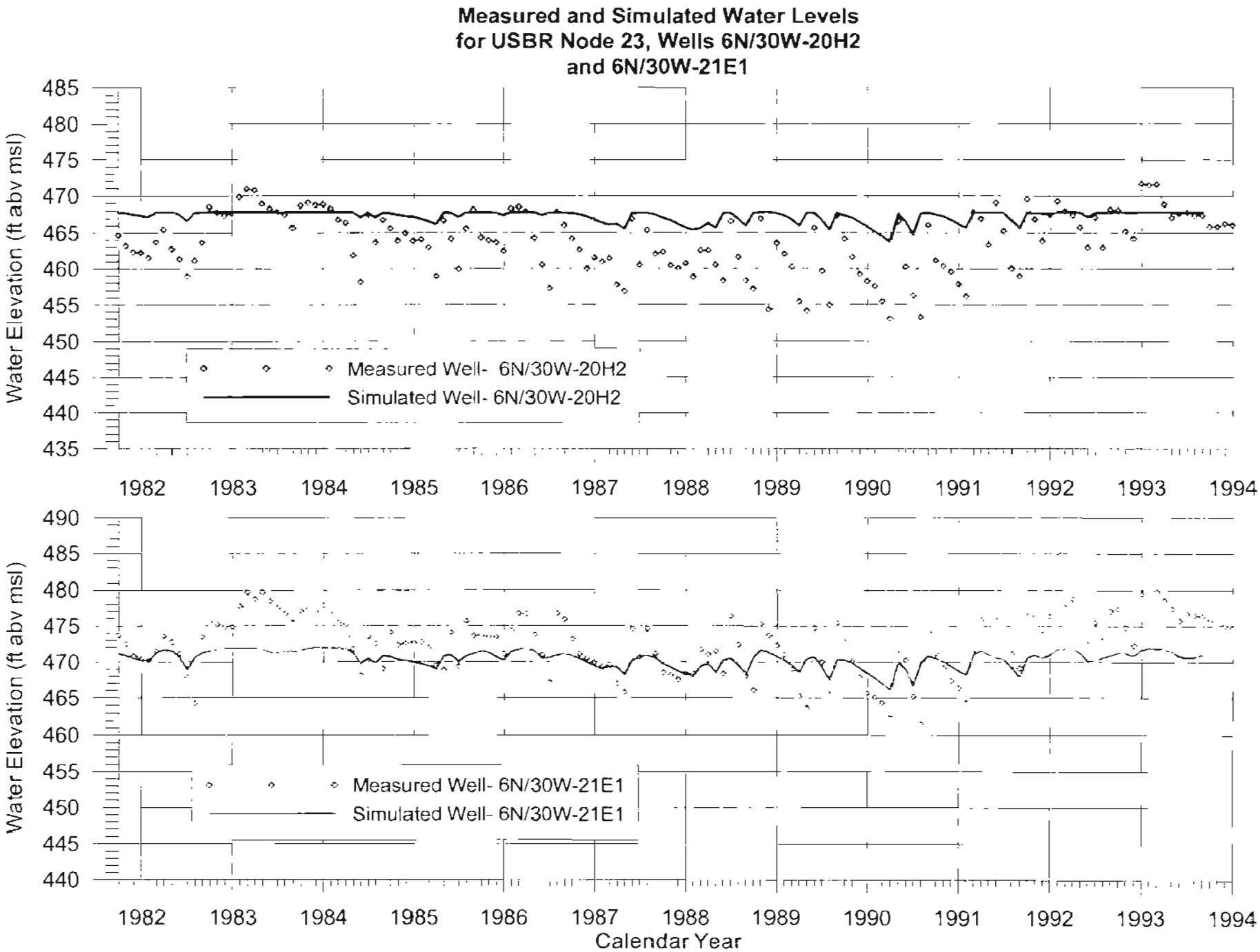

Measured and Simulated Water Levels
for USBR Node 23, Wells 6N/30W-20H2
and 6N/30W-21E1
Water Elevation (ft abv msl)
485
480
475
470
465
460
455
450
445
440
435
Measured Well- 6N/30W-20H2
Simulated Well- 6N/30W-20H2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Water Elevation (ft abv msl)
490
485
480
475
470
465
460
455
450
445
440
Measured Well- 6N/30W-21E1
Simulated Well- 6N/30W-21E1
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Calendar Year

Figure 9

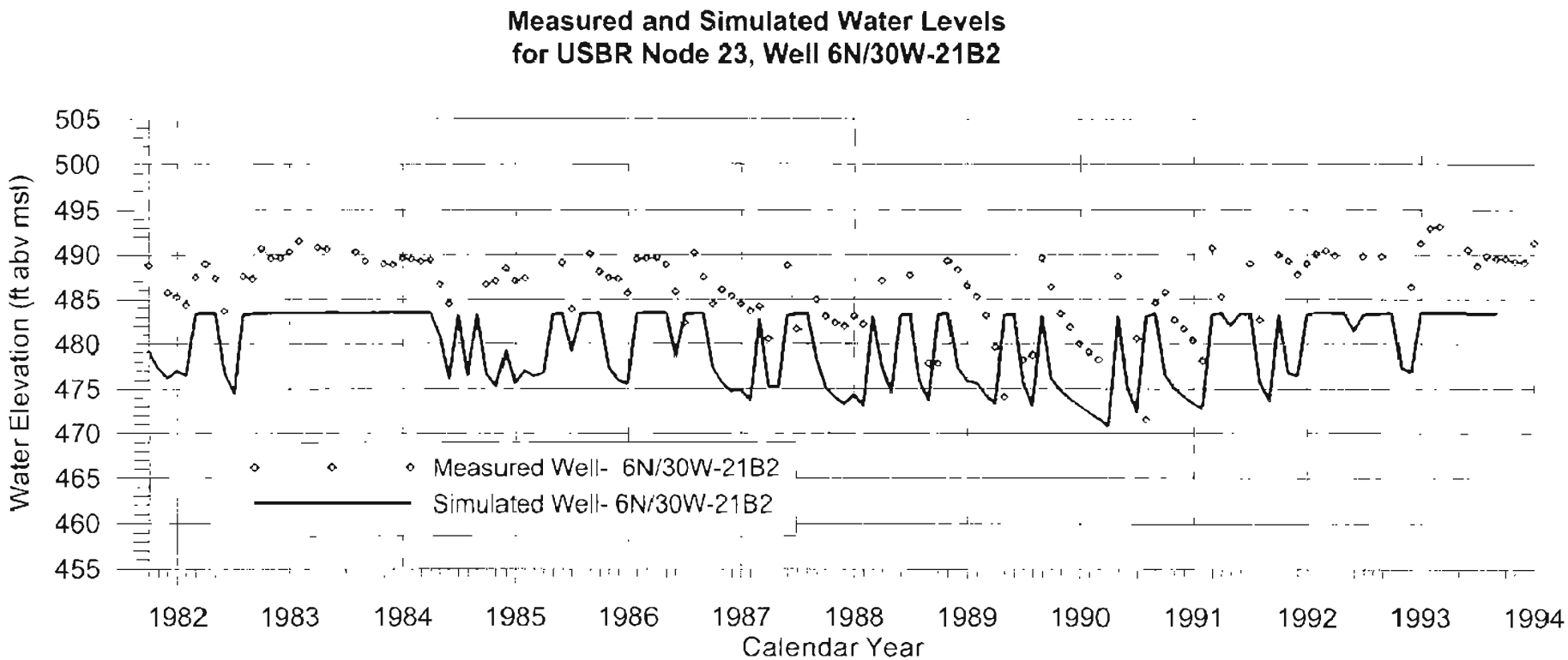

Measured and Simulated Water Levels
for USBR Node 23, Well 6N/30W-21B2
Water Elevation (ft abv msl)
505
500
495
490
485
480
475
470
465
460
455
Measured Well- 6N/30W-21B2
Simulated Well- 6N/30W-21B2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Calendar Year

Figure 10

Figure 11

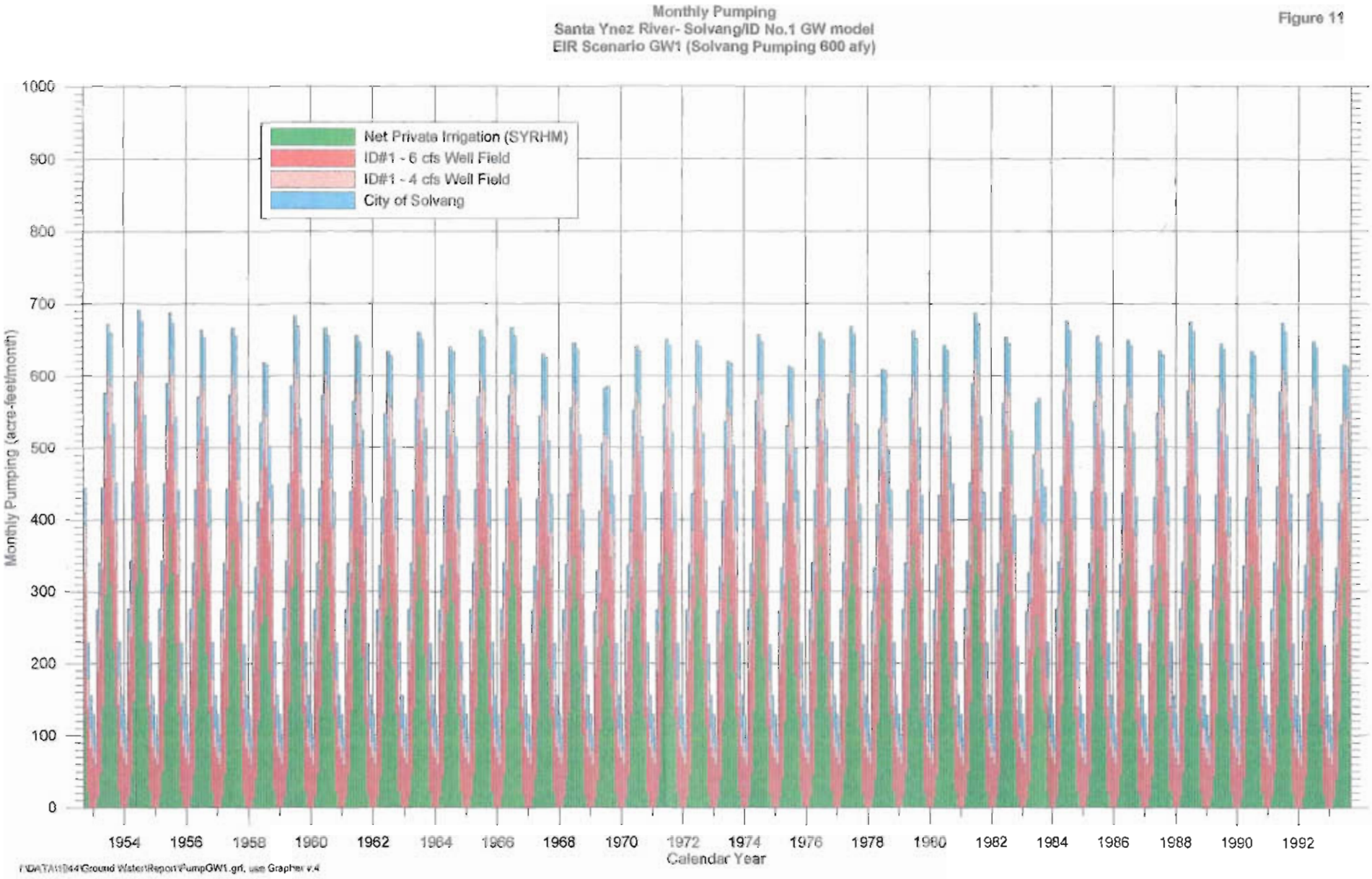

Monthly Pumping
Santa Ynez River- Solvang/ID No.1 GW model
EIR Scenario GW1 (Solvang Pumping 600 afy)
Net Private Irrigation (SYRHM)
ID#1 - 6 cfs Well Field
ID#1 - 4 cfs Well Field
City of Solvang
Monthly Pumping (acre-feet/month)
0
100
200
300
400
500
600
700
800
900
1000
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
Calendar Year
F:\DATA\1044\Ground Water\Report\PumpGW1.grf, use Grapher v.4

Figure 12

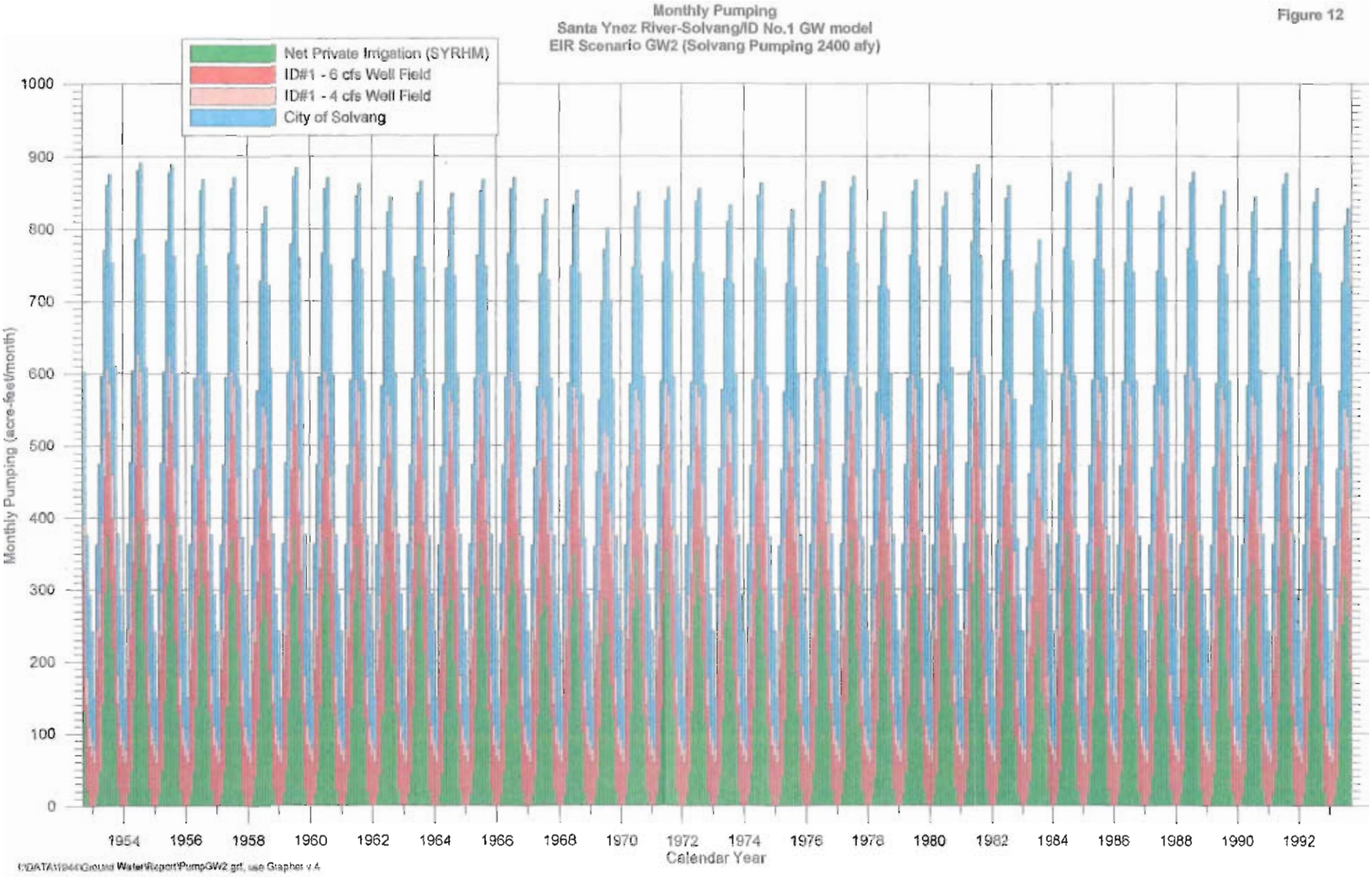

Monthly Pumping
Santa Ynez River-Solvang/ID No.1 GW model
EIR Scenario GW2 (Solvang Pumping 2400 afy)
Net Private Irrigation (SYRHM)
ID#1 - 6 cfs Well Field
ID#1 - 4 cfs Well Field
City of Solvang
Monthly Pumping (acre-feet/month)
0
100
200
300
400
500
600
700
800
900
1000
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
Calendar Year

Figure 13

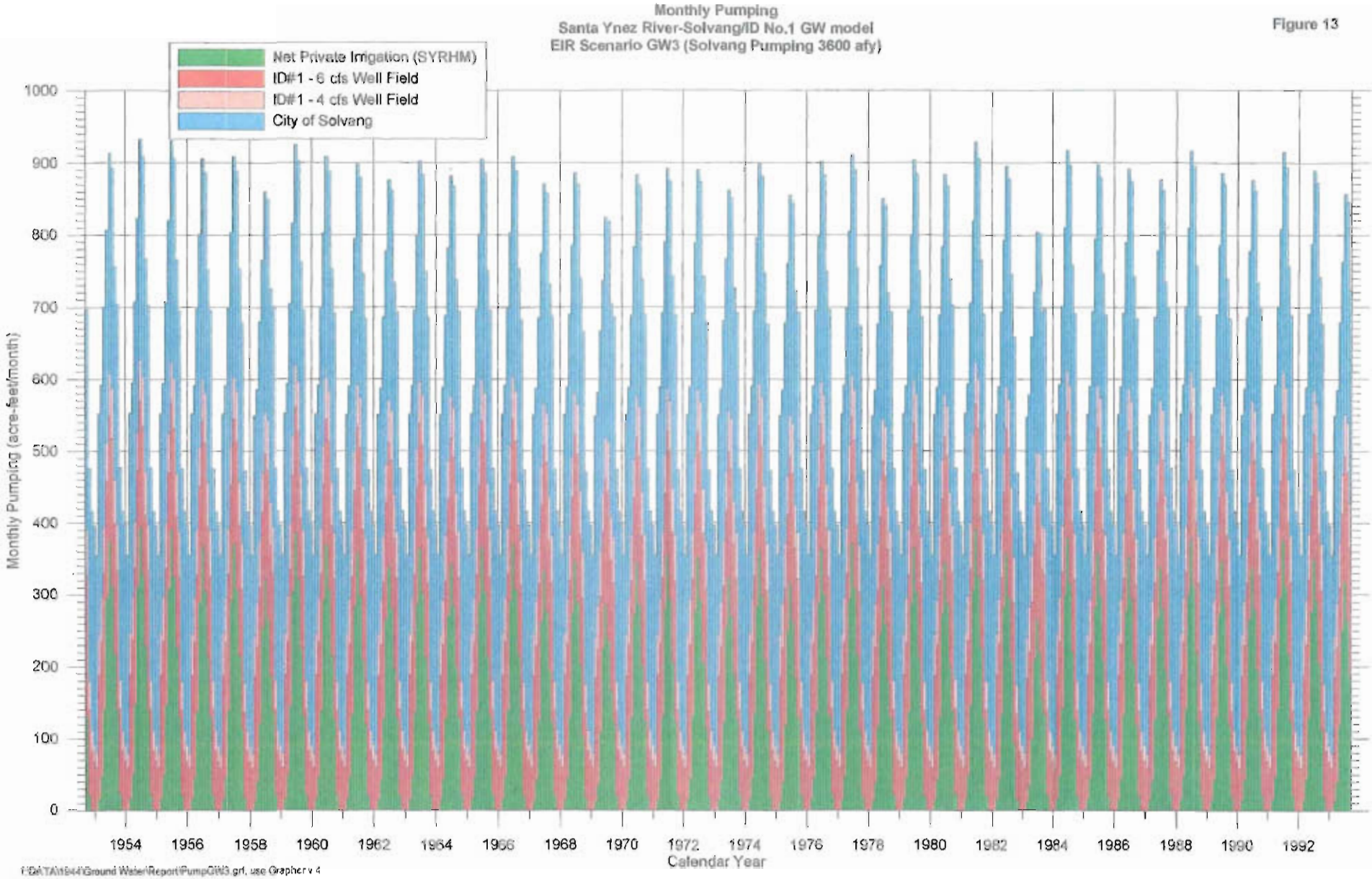
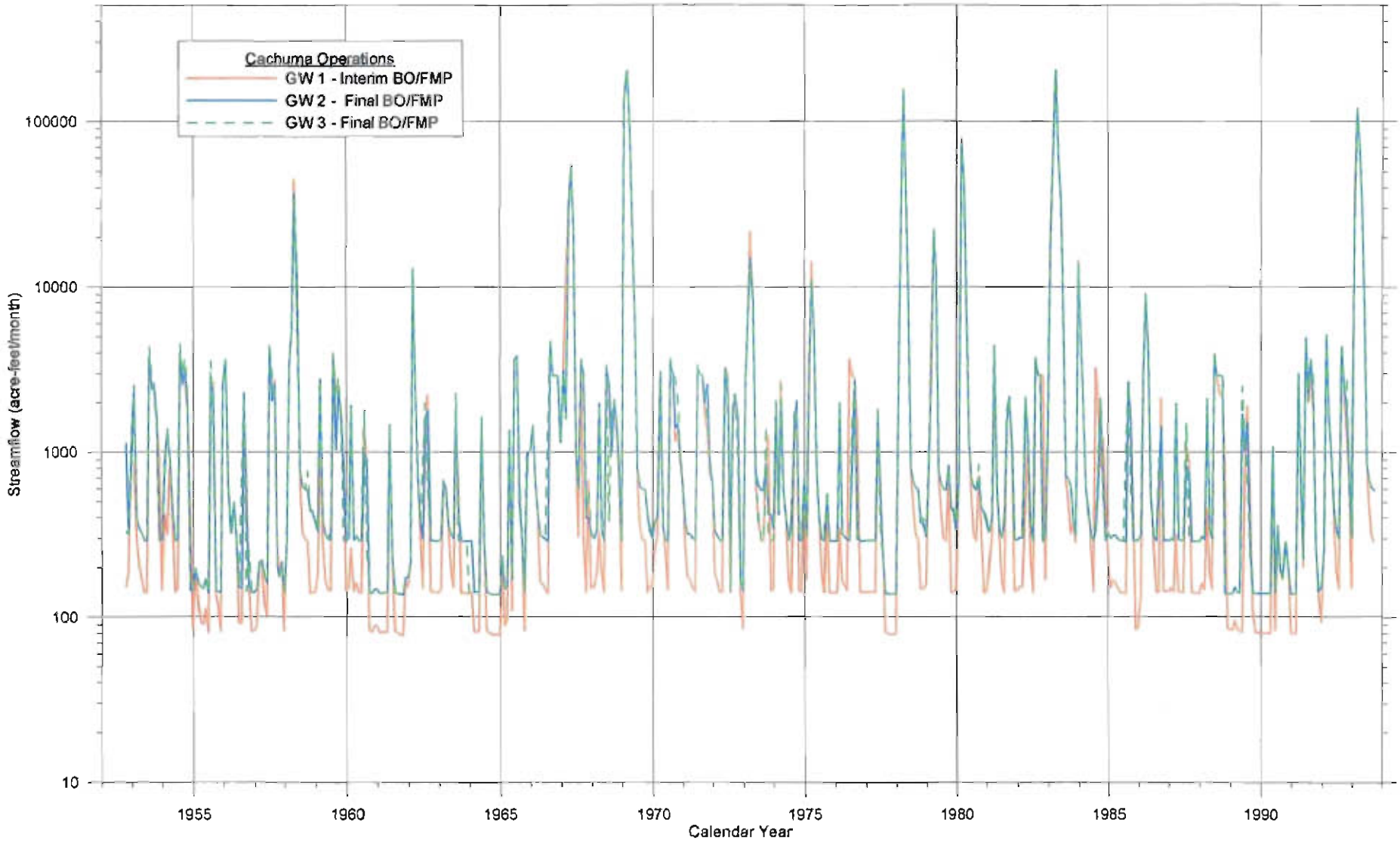
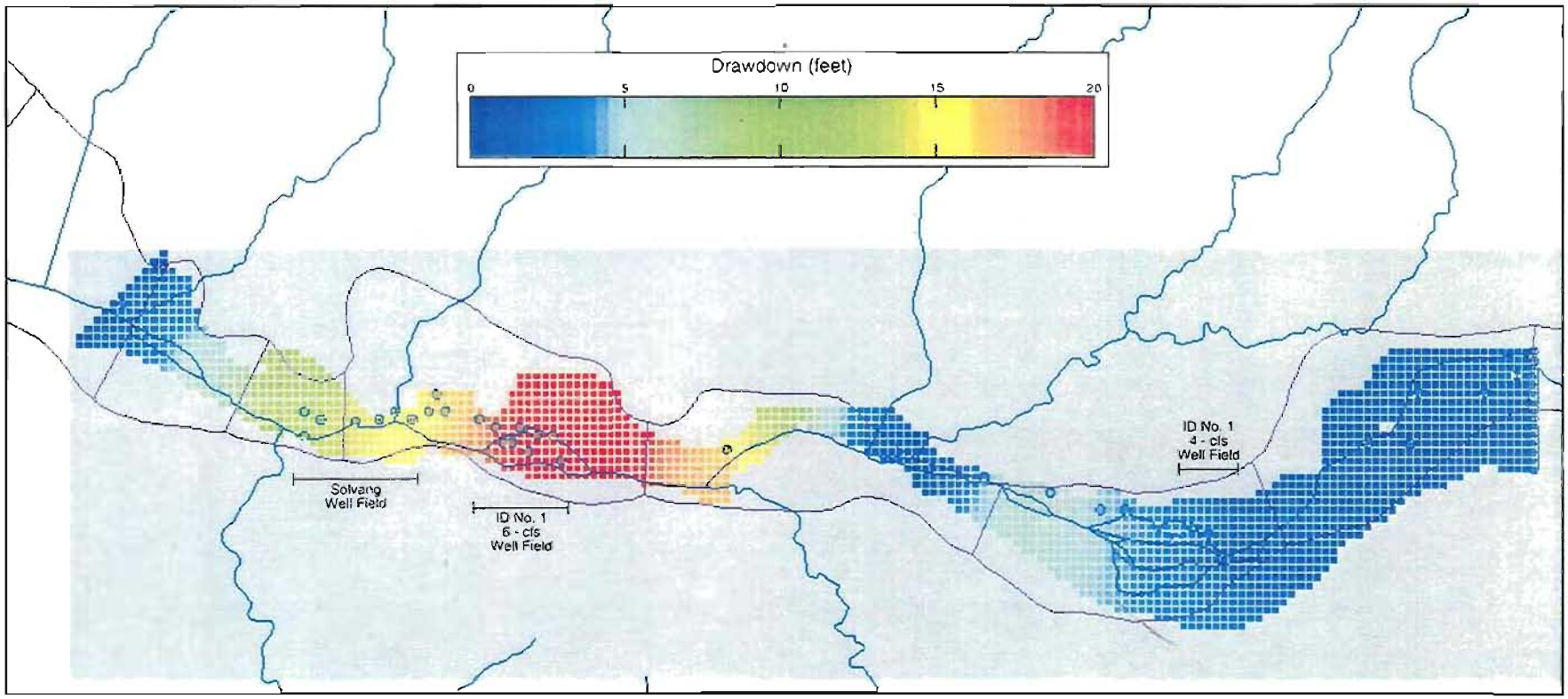

Monthly Pumping
Santa Ynez River-Solvang/ID No.1 GW model
EIR Scenario GW3 (Solvang Pumping 3600 afy)
Net Private Irrigation (SYRHM)
ID#1 - 6 cfs Well Field
ID#1 - 4 cfs Well Field
City of Solvang
Monthly Pumping (acre-feet/month)
0
100
200
300
400
500
600
700
800
900
1000
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
Calendar Year
F:\Dr\TA\1944\Ground Water\Report\PumpGW3.grf, use Grapher v 4

Figure 14

Santa Ynez River Input into the Solvang EIR Modflow Simulations at USBR Node 23
Source: Santa Ynez River Hydrology Model (SYRHM)

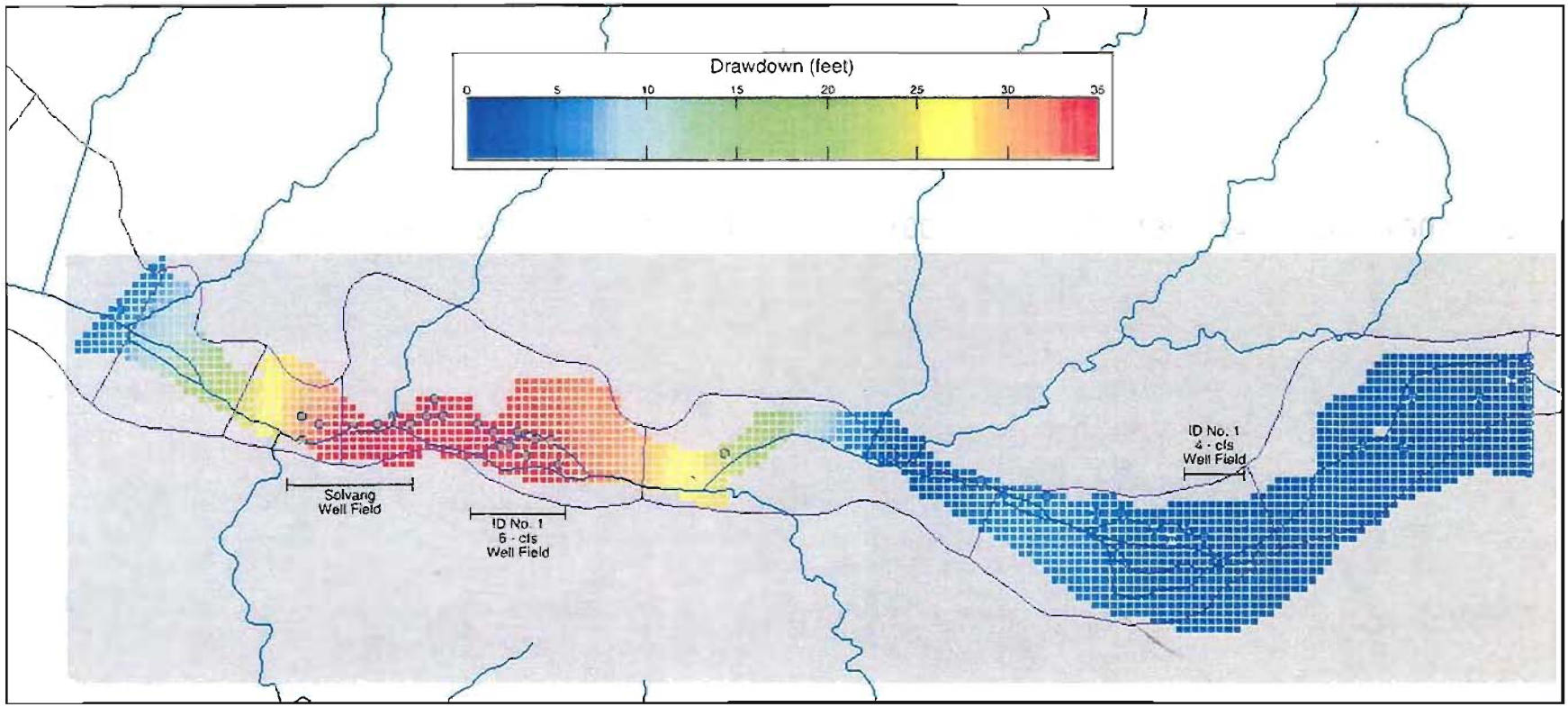




STETSON ENGINEERS INC.

Scenario GW 1, Maximum Drawdown
(November 1990)

FIGURE 15

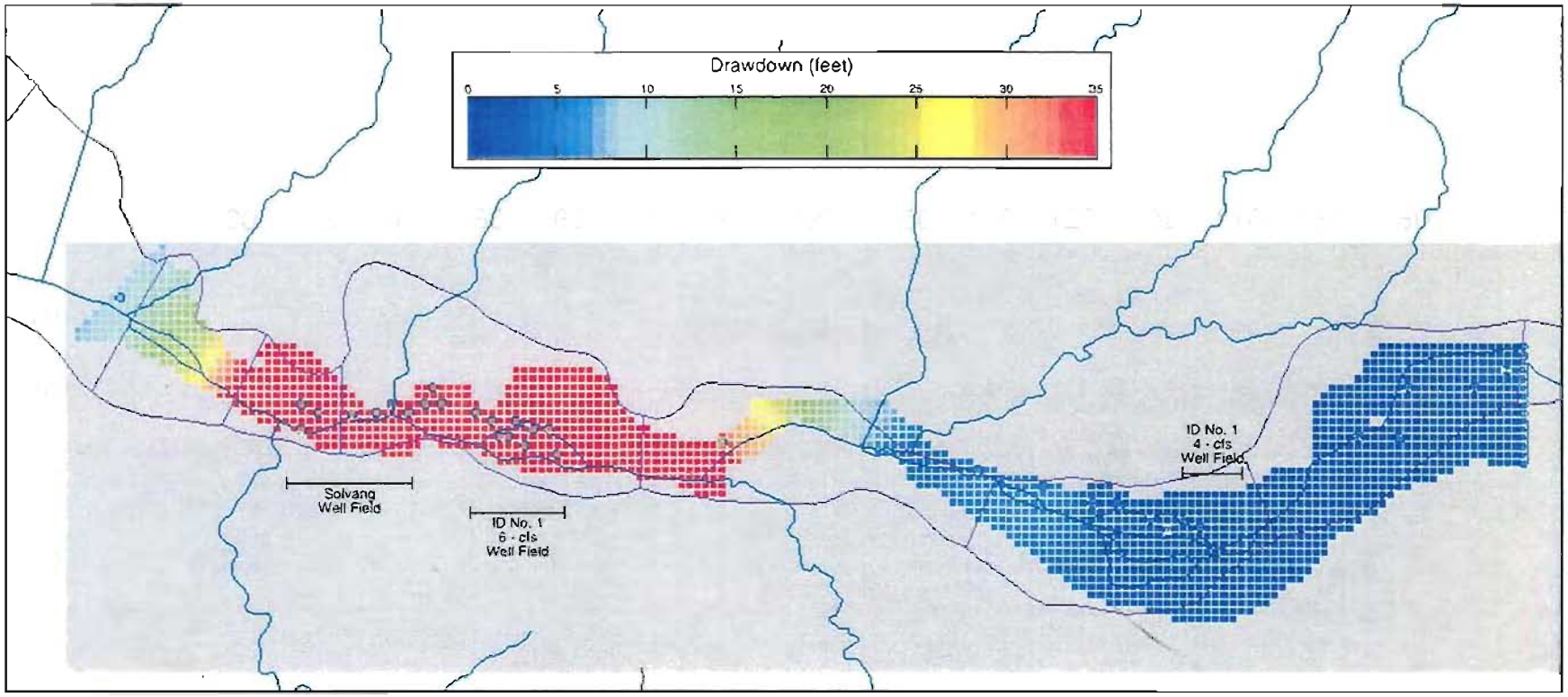


STETSON ENGINEERS INC.

Scenario GW 2, Maximum Drawdown
(November 1990)

FIGURE 16

1544/ColorFlood 3.ai



STETSON ENGINEERS INC.

Scenario GW 3, Maximum Drawdown
(February 1991)

FIGURE 17

Figure 18

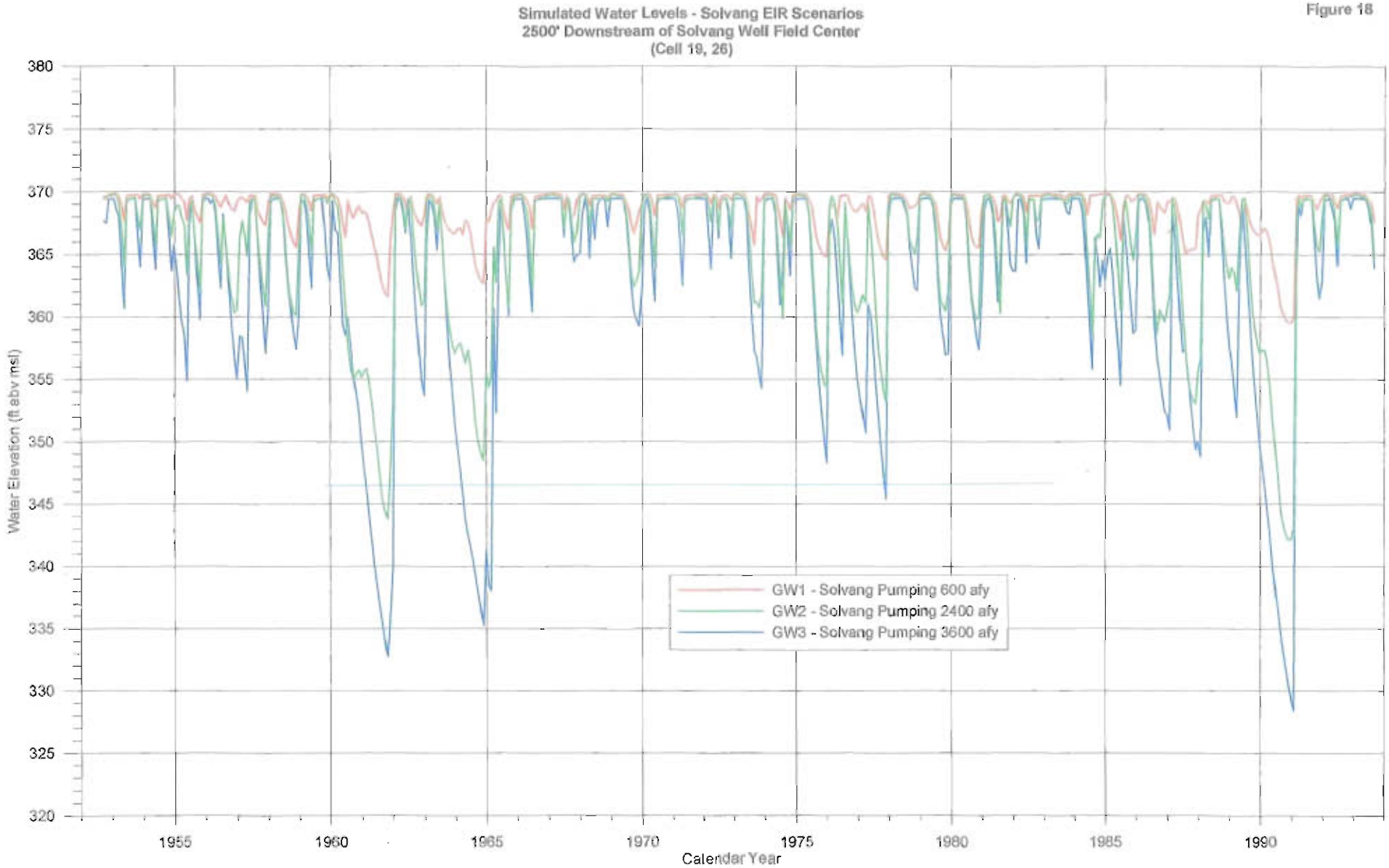

Simulated Water Levels - Solvang EIR Scenarios
2500' Downstream of Solvang Well Field Center
(Cell 19, 26)
Water Elevation (ft abv msl)
380
375
370
365
360
355
350
345
340
335
330
325
320
1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year
GW1 - Solvang Pumping 600 afy
GW2 - Solvang Pumping 2400 afy
GW3 - Solvang Pumping 3600 afy

Figure 19

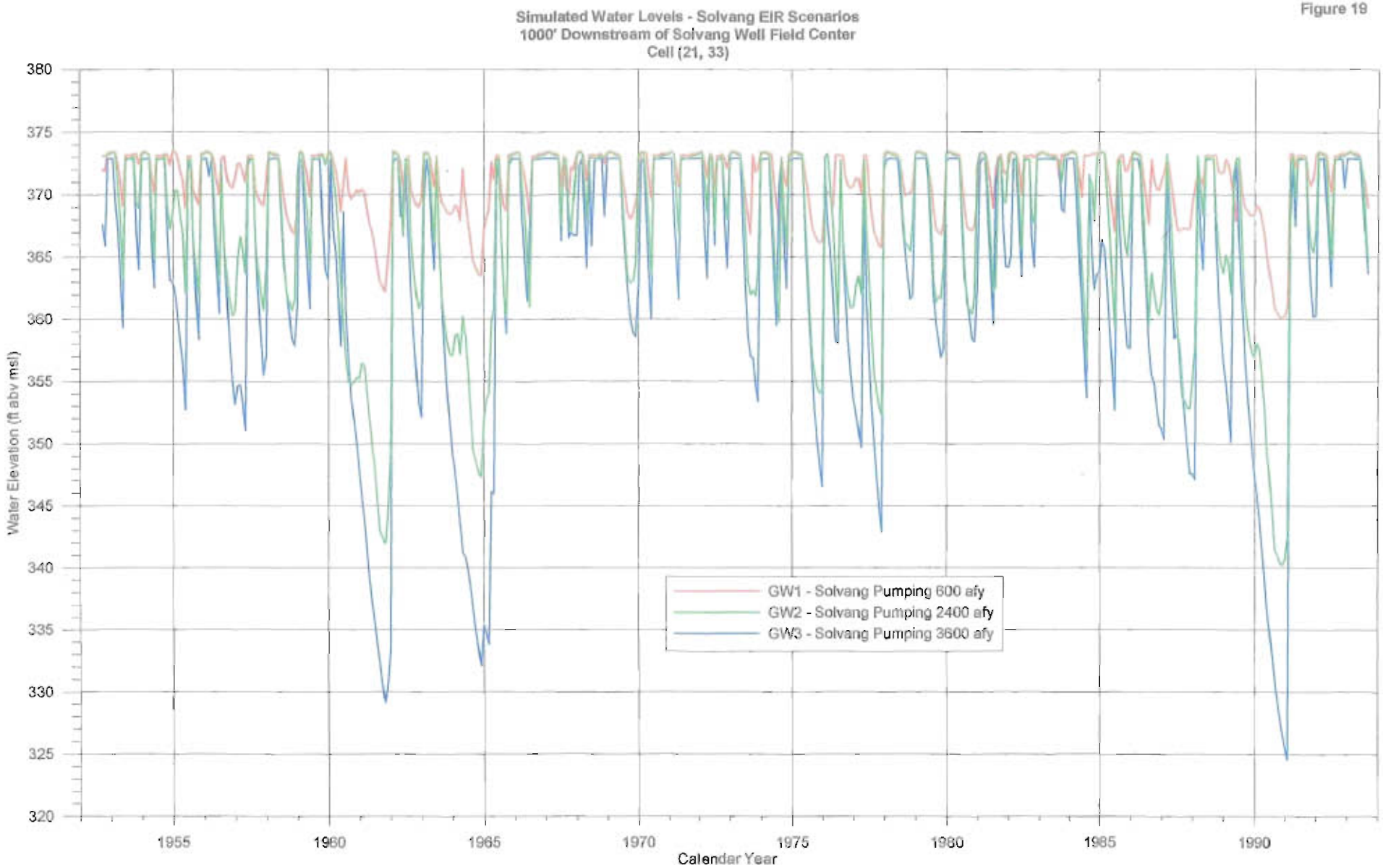

Simulated Water Levels - Solvang EIR Scenarios
1000' Downstream of Solvang Well Field Center
Cell (21, 33)
Water Elevation (ft abv msl)
380
375
370
365
360
355
350
345
340
335
330
325
320
1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year
GW1 - Solvang Pumping 600 afy
GW2 - Solvang Pumping 2400 afy
GW3 - Solvang Pumping 3600 afy

Figure 20

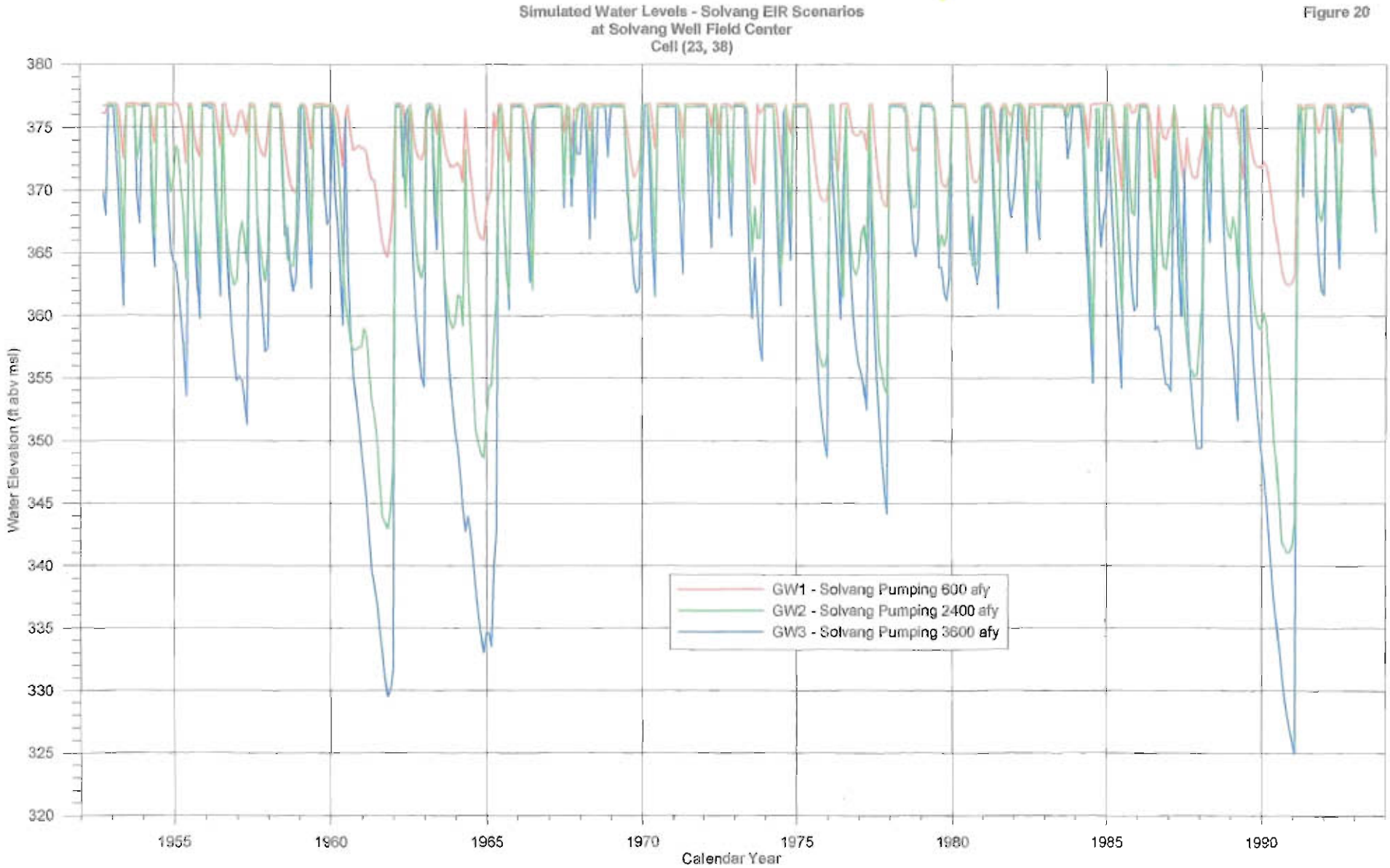
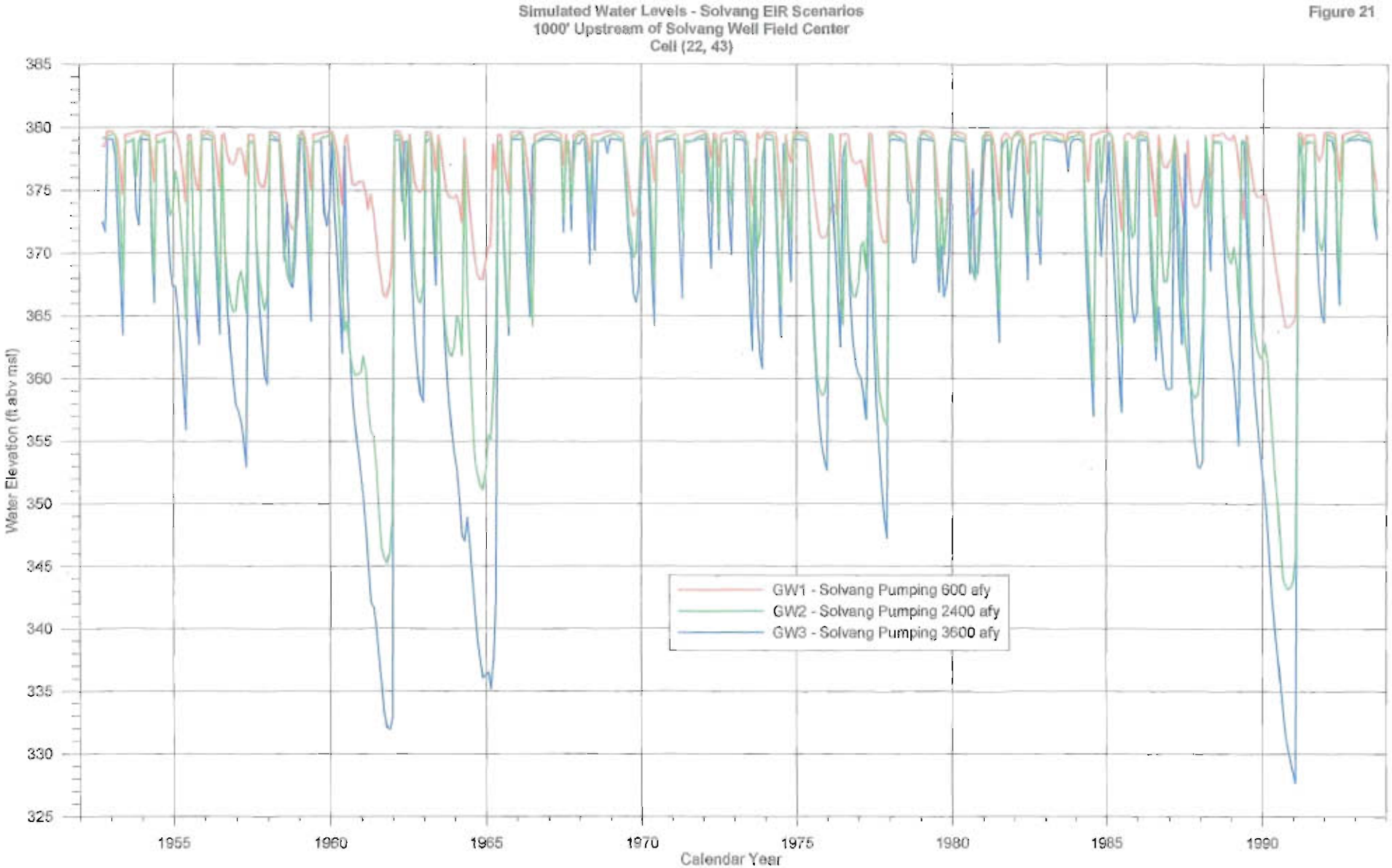
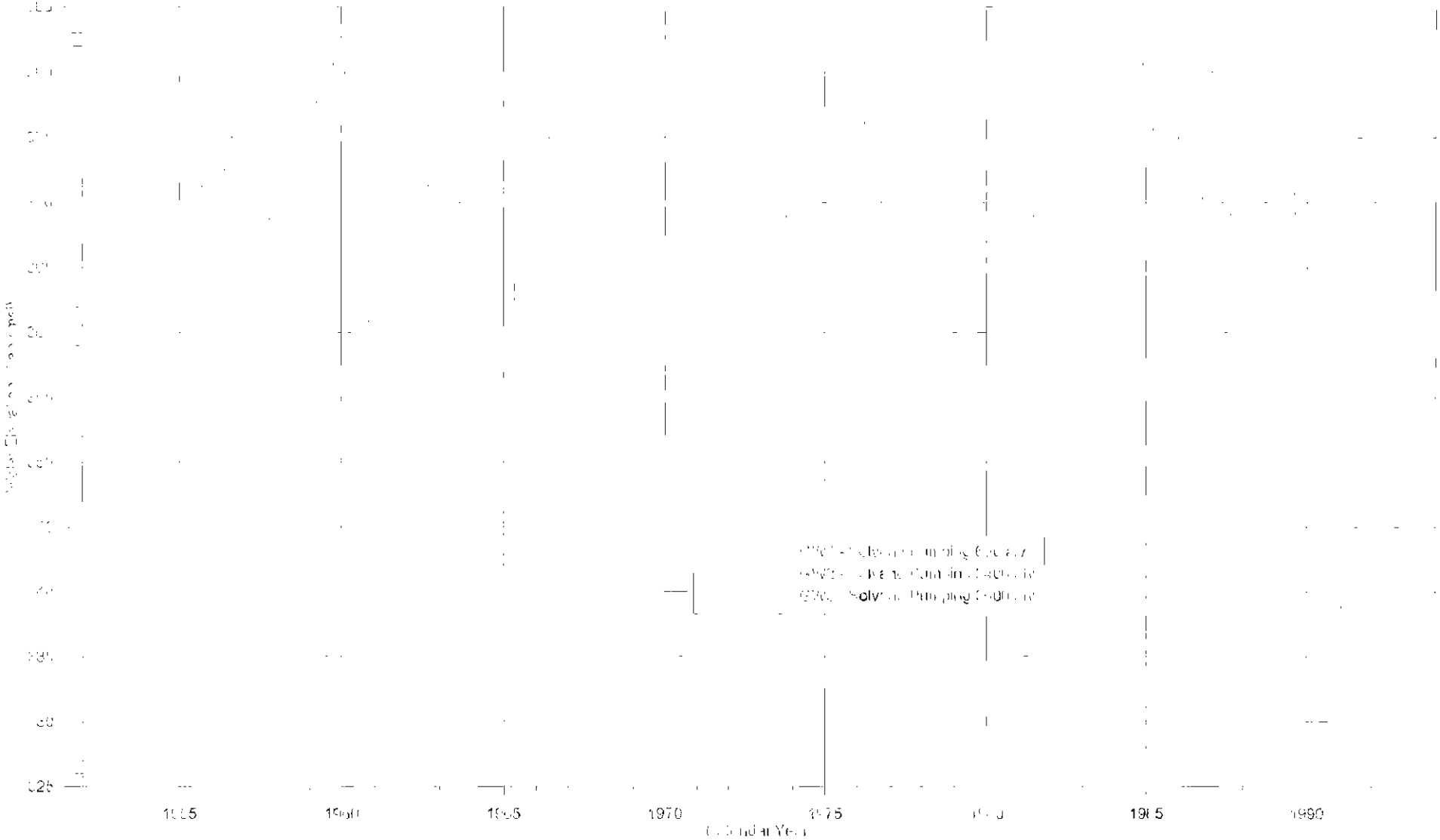

Simulated Water Levels - Solvang EIR Scenarios
at Solvang Well Field Center
Cell (23, 38)
Water Elevation (ft abv msl)
380
375
370
365
360
355
350
345
340
335
330
325
320
1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year
GW1 - Solvang Pumping 600 afy
GW2 - Solvang Pumping 2400 afy
GW3 - Solvang Pumping 3600 afy

Figure 21


Simulated Water Levels - Solvang EIR Scenarios
1000' Upstream of Solvang Well Field Center
Cell (22, 43)
Water Elevation (ft abv msl)
385
380
375
370
365
360
355
350
345
340
335
330
325
1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year
GW1 - Solvang Pumping 600 afy
GW2 - Solvang Pumping 2400 afy
GW3 - Solvang Pumping 3600 afy


1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year

Simulated Water Levels - Solvang EIR Scenarios
Near Well 6N/31W - 22F1, USBR Node 20 (cell 18, 43; well located just outside model bndy)

Figure 23

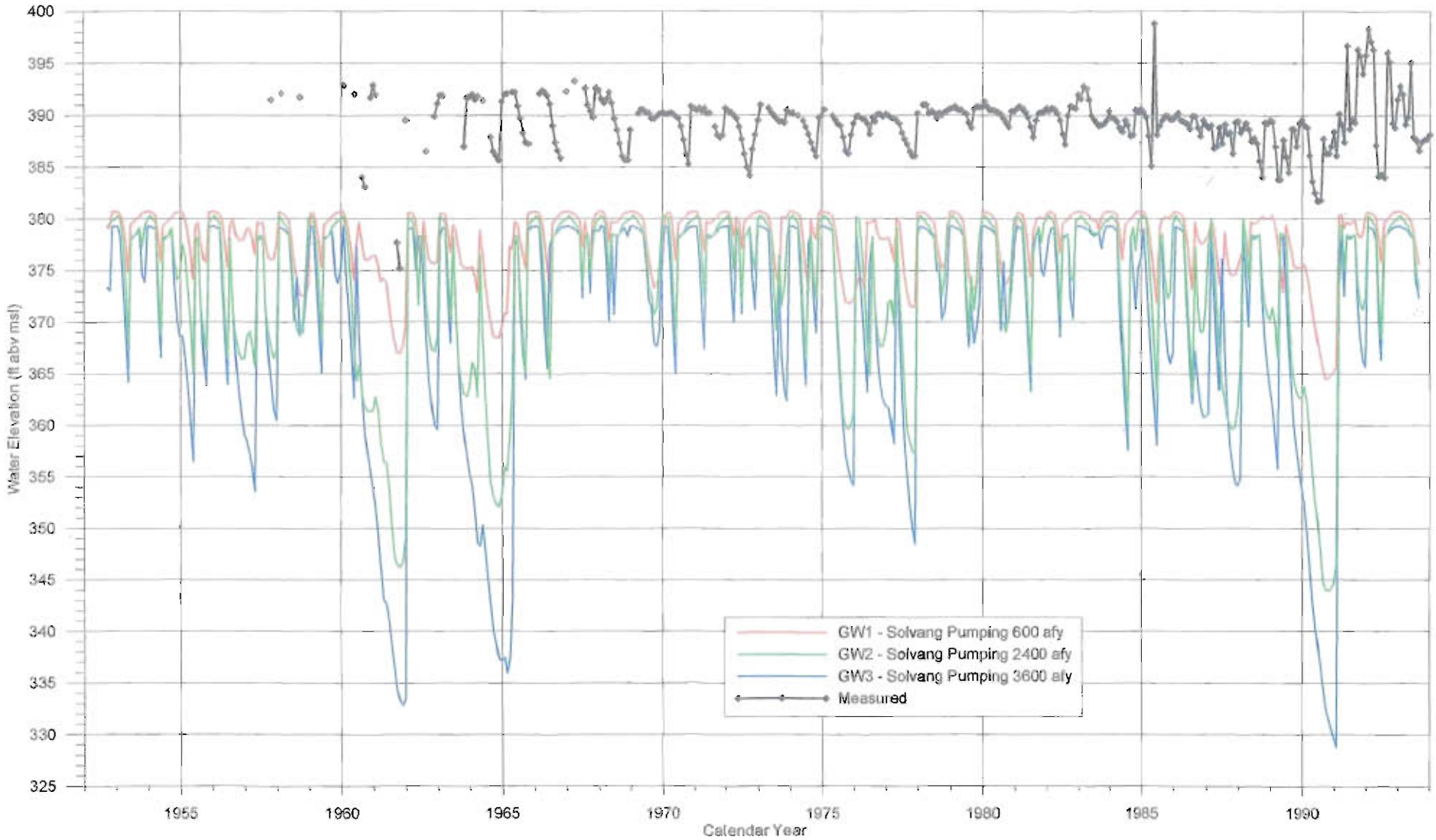
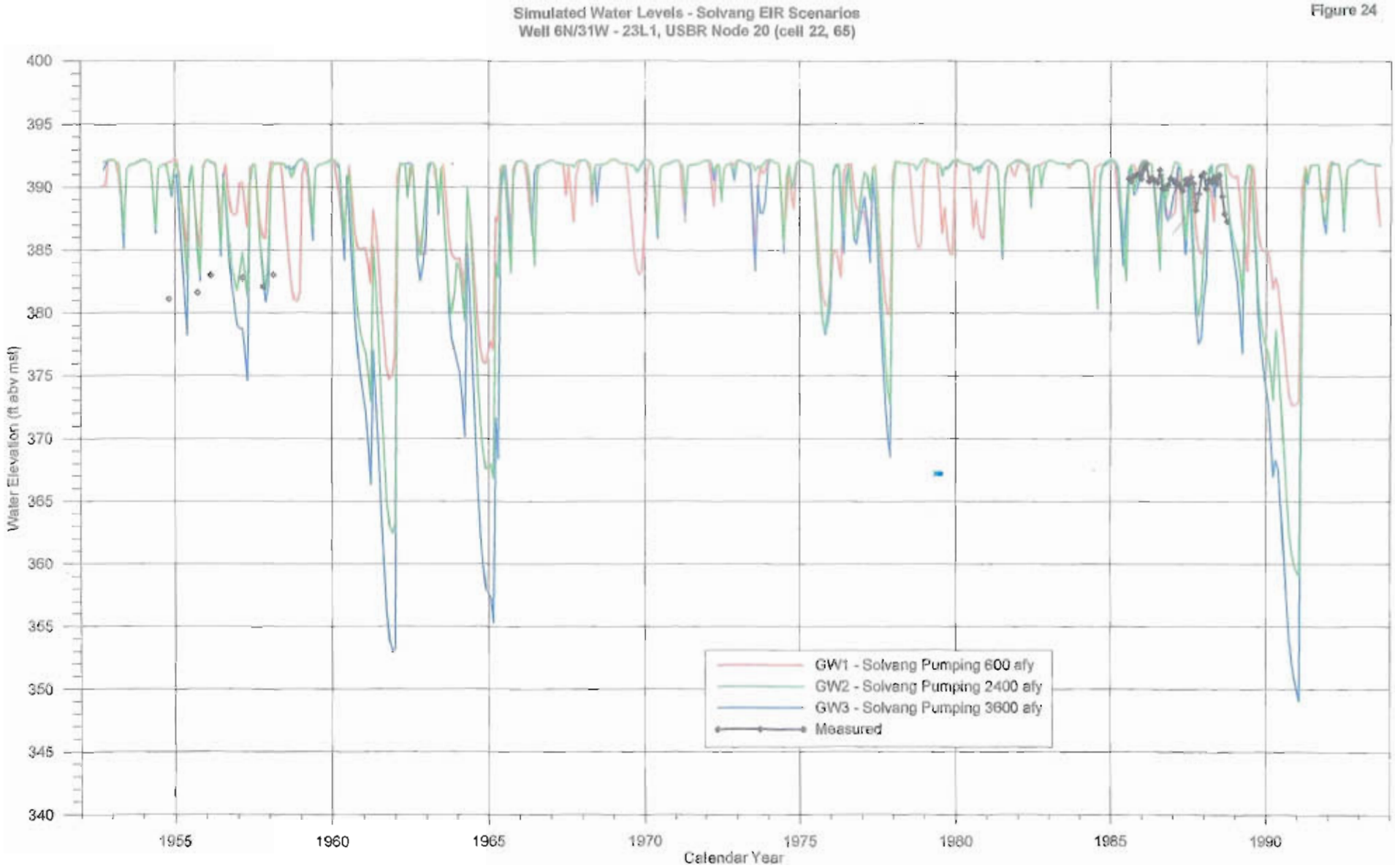
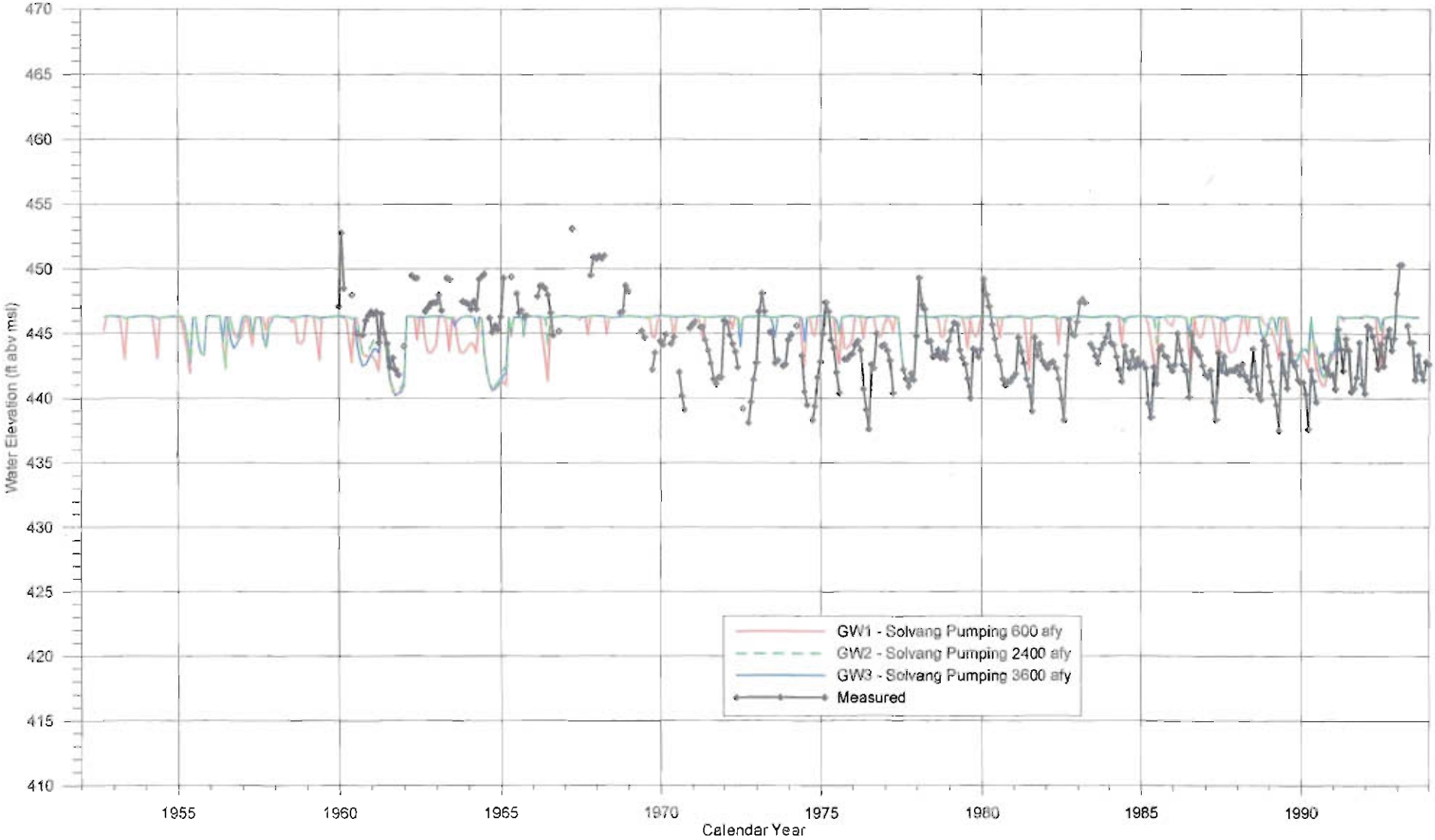


Figure 24


Simulated Water Levels - Solvang EIR Scenarios
Well 6N/31W - 23L1, USBR Node 20 (cell 22, 65)
Water Elevation (ft abv msl)
400
395
390
385
380
375
370
365
360
355
350
345
340
1955
1960
1965
1970
1975
1980
1985
1990
Calendar Year
GW1 - Solvang Pumping 600 afy
GW2 - Solvang Pumping 2400 afy
GW3 - Solvang Pumping 3600 afy
Measured

Simulated Water Levels - Solvang EIR Scenarios
Well 6N/30W - 19Q2, USBR Node 22 (cell 36, 125)

Figure 25



Simulated Water Levels - Solvang EIR Scenarios
Well 6N/30W - 21B2, USBR Node 23 (cell 15, 176)

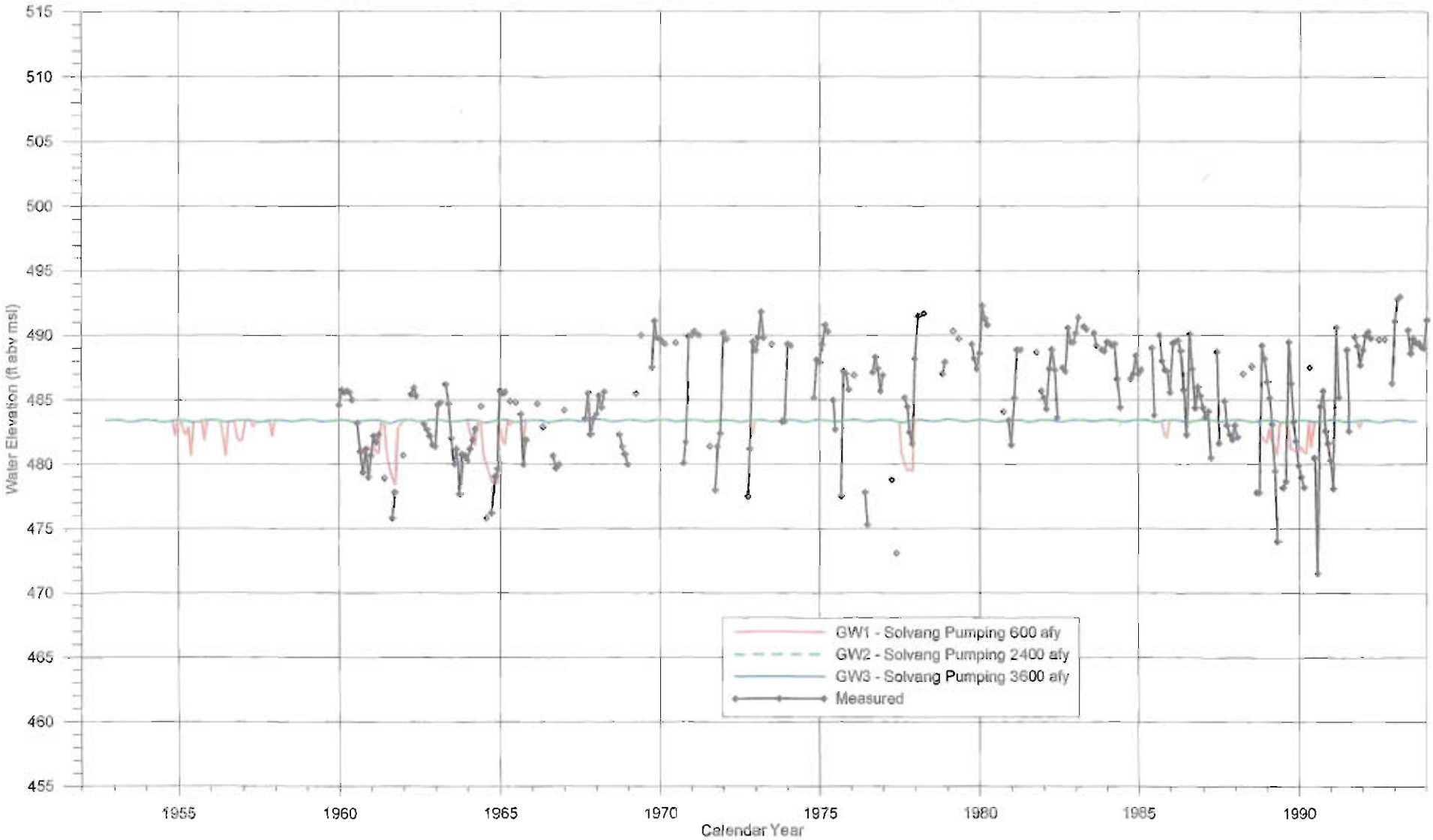



Figure 26