STONY CREEK FAN AQUIFER PERFORMANCE TEST
GLENN COUNTY, CALIFORNIA
Township 21 North, Range 2 West, Section 1

Prepared by the California Department of Water Resources
Northern District Groundwater Section
in Cooperation with
Glenn County Department of Agriculture

October 2004

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This summary report was prepared by the Department of Water Resources, Northern District, Groundwater Section, on behalf of the Glenn County Department of Agriculture. It was prepared under the direct supervision of Toccoy Dudley, Chief of the Northern District Groundwater Section, Registered Geologist No. 3732, and was written by Kelly Staton, Registered Geologist No. 7501, in accordance with the provisions of the Geologist and Geophysicists Act of the State of California.

Kelly Staton
Engineering Geologist
CA Registered Geologist No. 7501
CA Certified Engineering Geologist No. 2337

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Introduction

Glenn County was awarded an AB303 grant in 2003 to perform two aquifer performance tests of the Stony Creek Fan aquifer system. The first of these aquifer tests was performed in March 2004 south of Stony Creek, in the eastern portion of the Stony Creek Fan. Figure 1 shows the location of the first aquifer performance test. This site is on Road 24 about 1.7 miles east of Highway 45, at St. John Farms. The second test will be performed in the spring of 2005 in the western part of the Stony Creek Fan alluvium.

The location of the first aquifer performance test was determined by members of the Glenn County Technical Advisory Committee and the California Department of Water Resources. Factors involving the site selection of the test location were total thickness of the Stony Creek Fan aquifer, location of existing dedicated observation wells, proximity to drainage facilities, and landowner permission.

Scope of Work

Starting on March 19, 2004, an aquifer performance test was performed on the Stony Creek Fan aquifer system to determine the transmissivity, storativity and hydraulic conductivity of the aquifer. Data needed to calculate these hydraulic properties were collected from existing observation wells and a test production well installed specifically for the aquifer performance test.

Prior to the test, groundwater levels were measured manually in eleven wells in the study area, as shown on Figure 2. These wells were monitored weekly for a period of one month prior to the test, multiple times daily throughout the step-drawdown and constant-discharge tests, and seven-days following the test as the groundwater levels recovered. Groundwater level measurements from these wells were used to determine if interference occurred from the test production well outside the test area.

Data loggers were used to continuously record groundwater levels in the test production well, the four observation wells, and an irrigation well that was in proximity to the test production well. Two of the four observation wells are screened in the Stony Creek Fan alluvium. Observation well 21N02W01F04M (01F04M) is screened in the upper Stony Creek Fan alluvium, from 55 to 65 feet. Observation well 21N02W01F03M (01F03M) is screened from 110 to 124 feet, and is in the lower part of the alluvium. Data from these wells were used to determine aquifer parameters.

A week before the test, a temporary well, SCF-AB303-8, was drilled and constructed to a total depth of 150 feet, as shown in Photo 1 and Figure 3. A diesel-powered test pump was then installed and discharge pipe was laid to convey the extracted water approximately 500 feet to an existing drainage system. Photos 2 and 3 show the discharge pipe and conveyance system. A McCrometer flow meter was mounted on the discharge pipe to measure the volume of water extracted.

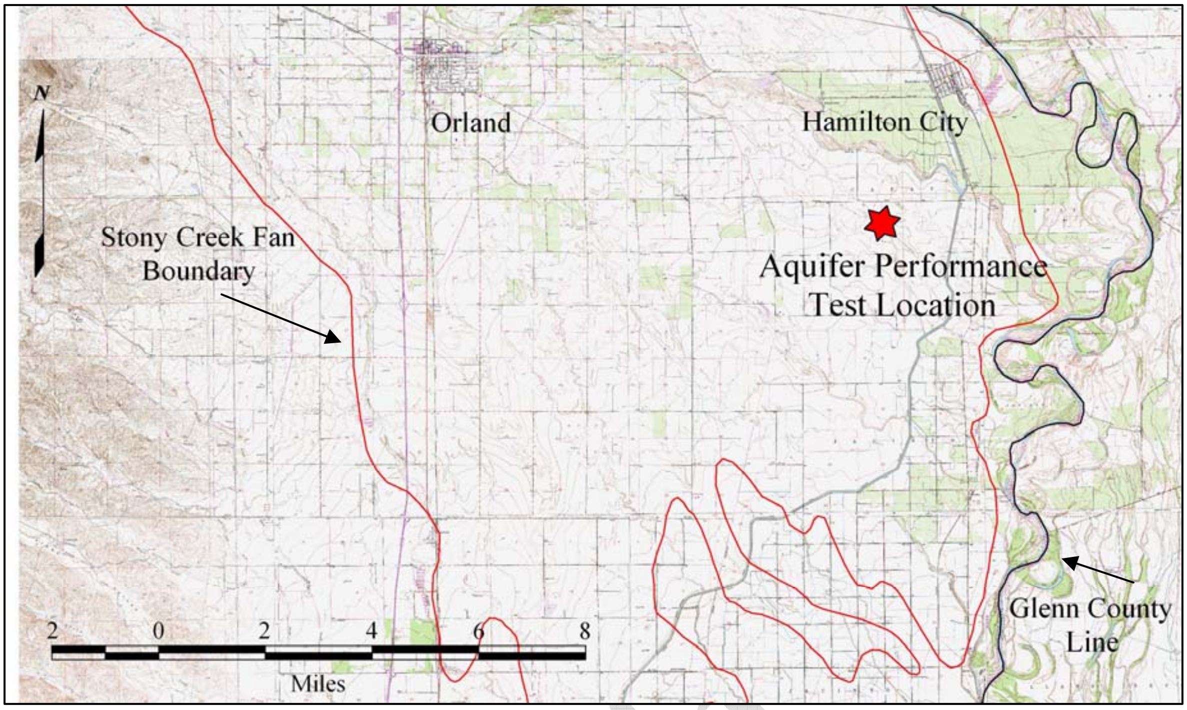


Figure 1. Location Map of Stony Creek Fan Aquifer Performance Test.

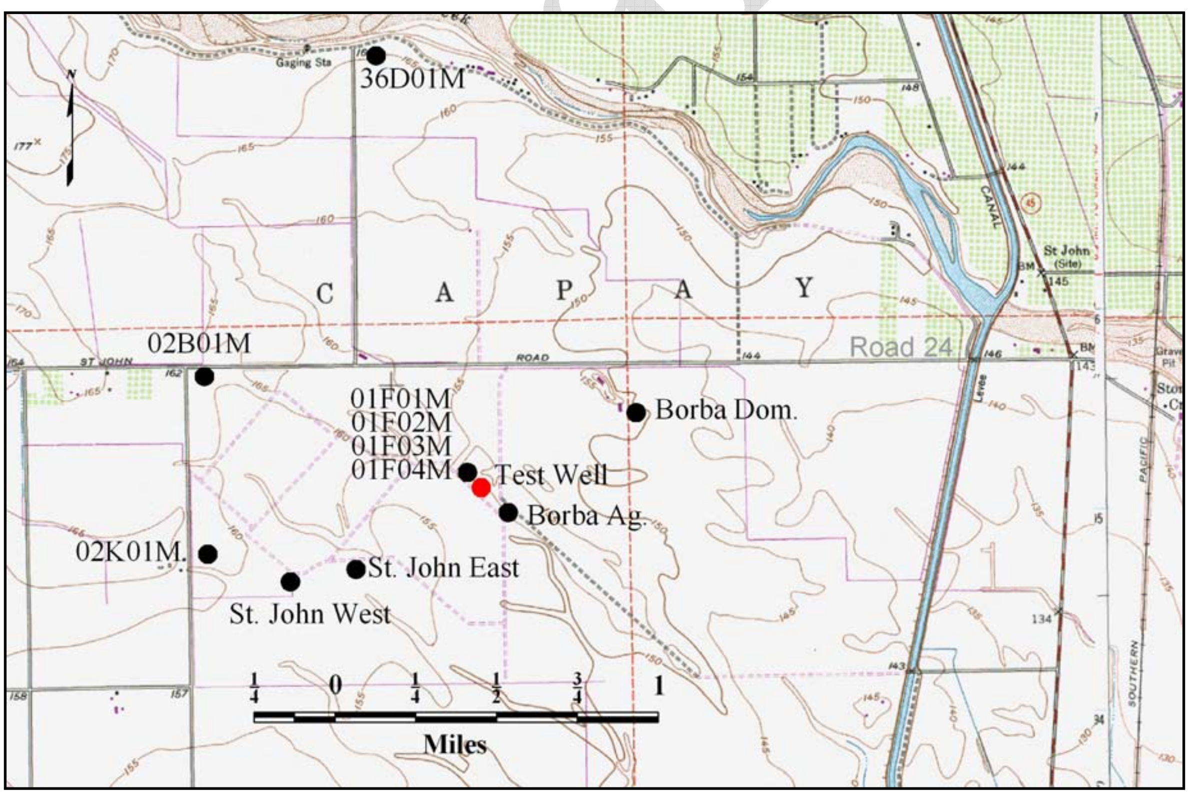


Figure 2. Location of Test Production Well, Observation Wells and Background Wells.

The well was then developed at varying flow rates, ranging from 600 gallons per minute (gpm) to 1,250 gpm. During development, a pre-test check on the drainage facilities was done to ensure the following:

- there was no leakage from the drainage pipe,
- water flowed away from the test site,
- there was no back flow of water or erosion of ditch walls and
- to make sure that constructed diversion barriers operated correctly.

Following well development, a step-drawdown test was performed on the test production well. The test pump was operated at the following flow rates for two hours each:

- 600 gpm
- 800 gpm
- 1000 gpm
- 1200 gpm.

The purpose of the step-drawdown test was to determine the highest flow rate at which the well would operate efficiently during the constant discharge test. After evaluating the step-drawdown test data, a flow rate of 700 gpm was determined to be the optimal flow rate at which to stress the aquifer while still ensuring laminar flow through the well screen.

The aquifer performance test began March 19, 2004 at 9:02 am. and continued until March 22, 2004 at 9:15 am, at which time the pump was turned off. Drawdown in the test production well, flow rate, and discharge volumes were recorded throughout the 72-hour constant discharge test. Water quality parameters were taken intermittently throughout development and testing to measure temperature, electrical conductivity and pH.

Photo 1. Test Production Well Prior to Pump Installation.

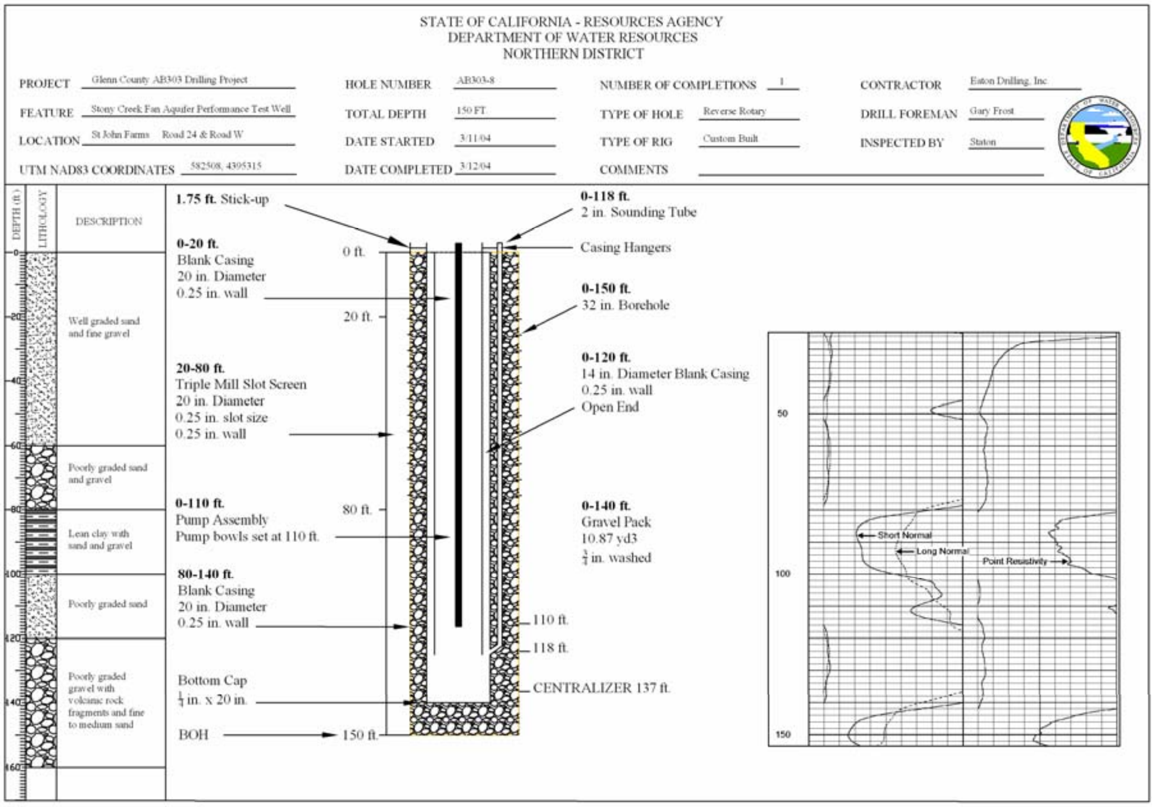


Figure 3. Lithology, Well Construction and Electric Resistivity Log.

Photo 2. Conveyance Pipe to Existing Drainage System.

Photo 3. Drainage System.

Results

Step-Drawdown Test.

A step-drawdown test was performed to determine the highest flow rate at which the test production well could operate efficiently during the constant discharge test. The step-drawdown test is evaluated by calculating the specific capacity of the well while operating the pump at varying discharge rates. The specific capacity is calculated by dividing the flow rate (usually in gallons per minute) by the measured drawdown in feet, in a well. The data from the step-drawdown test are used to determine the extraction rate at which groundwater entering the well changes from laminar to turbulent flow.

During this test, the pump was operated at 600, 800, 1000 and 1200 gpm for two hours at each rate. Figure 4 is a graph of the step-drawdown test showing the rate, drawdown and specific capacity for each two-hour interval. The specific capacity of the test production well ranged from a high of 75 gallons per minute per foot of drawdown (gpm/ft dd) at 600 gpm to a low of 25 gpm/ft dd at 1200 gpm which is summarized in Table 1.

Figure 5 shows a graph of the specific capacity vs. discharge in gallons per minute. The break in slope at 800 gpm is the point at which turbulent flow occurs in the well. At this location, a flow rate of 700 gpm was determined to be the best flow rate at which to stress the aquifer while still ensuring laminar flow into the well.

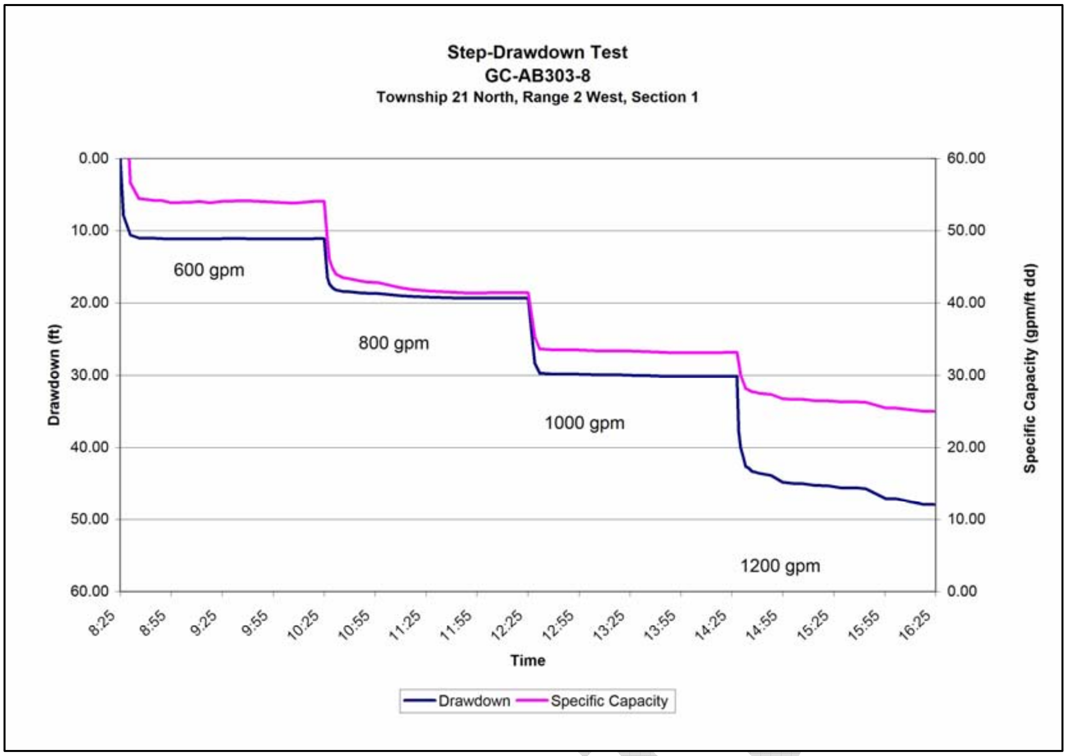


Figure 4. Step-Drawdown Test.

	Specific Capacity (gpm/ft dd)		
GPM	High	Low	Average
600	76	54	56
800	49	41	43
1000	35	33	34
1200	32	25	27

Table 1. Specific Capacity during Step-Drawdown Test

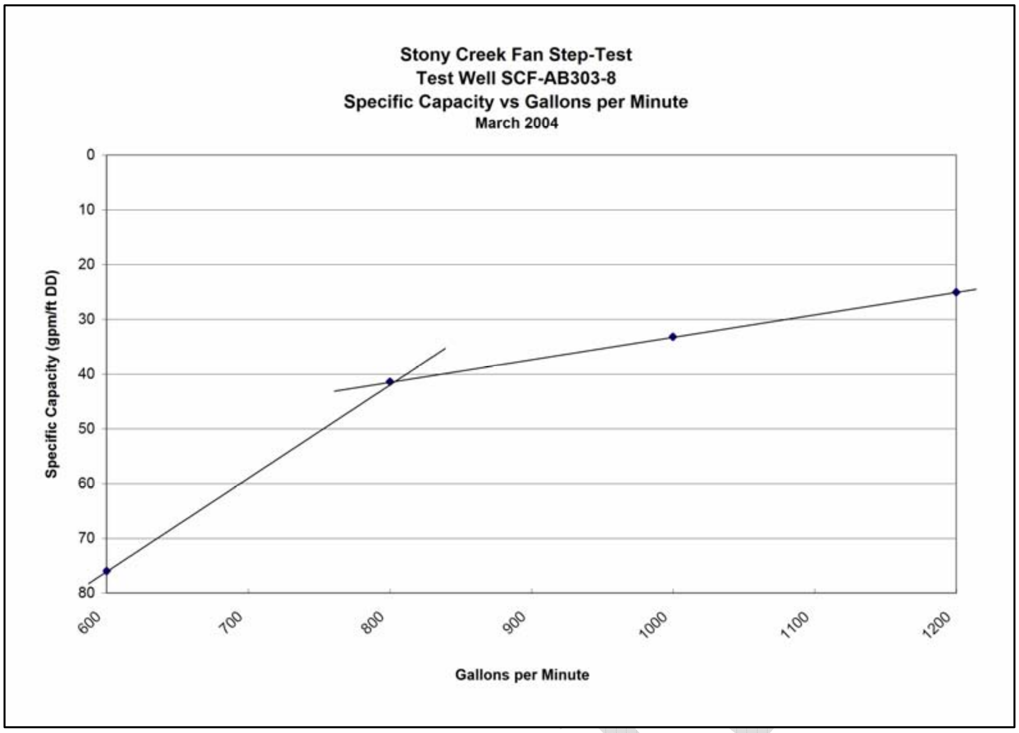


Figure 5. Specific Capacity vs. Discharge (gpm)

Aquifer Performance Test.

A constant discharge aquifer performance test was performed to determine the hydrogeologic properties of an aquifer. The three main aquifer parameters calculated were transmissivity, storativity and hydraulic conductivity. Transmissivity and storativity values were calculated using the Jacob Straight-Line method for time-drawdown series data; hydraulic conductivity is determined from the transmissivity.

Transmissivity is defined as the ability of an aquifer to transmit water through a saturated thickness, and is often expressed in gallons per day per foot (gpd/ft). For perspective, transmissivity values less than 1,000 gpd/ft will usually supply only enough water for domestic wells or other low-yield purposes. In wells with transmissivity values higher than 10,000 gpd/ft., well yields should be sufficient for industrial, municipal or irrigation purposes.

Transmissivity was calculated at about 543,500 gpd/ft. in observation well 01F04M and about 684,500 gpd/ft. in observation well 01F03M, for an average transmissivity value of about 307,000 gpd/ft. In the test production well, SCF-AB303-8, the calculated transmissivity ranged from about 369,600 gpd/ft over the test period from 10 to 100 minutes, to approximately 142,200 gpd/ft over the test period from 100 to 1000 minutes, averaging around 255,900 gpd/ft. The overall average transmissivity using both observation wells and the test production well data is about 406,525 gpd/ft. The time-drawdown graphs for the test production well and the two observation wells are shown in Figures 6, 7 and 8.

The calculated aquifer storativity, or storage coefficient, is defined as the volume of water taken into or released from storage per unit change in head per unit area. The aquifer storage coefficient is reported in dimensionless units. In an unconfined aquifer, the storativity is equal to the specific yield. The storativity for observation well 01F04M was calculated to be about 0.002148 and about 0.000259 for observation well 01F03M, suggesting that the aquifer is semi-confined. However, geologic information suggests that the upper aquifer system is unconfined. A storativity value cannot be calculated from data collected in a pumping well.

Hydraulic conductivity is defined as the capability of a porous medium to transmit water, and is calculated by dividing the transmissivity by the saturated thickness of the aquifer. In observation wells 01F04M and 01F03M, the hydraulic conductivity was calculated to be about 4,500 gpd/ft^2 and 5,700 gpd/ft^2, respectively, which is typical for fine to coarse gravel and sand. In the test production well, the hydraulic conductivity ranged from about 1,200 gallons per day per foot squared (gpd/ft^2) to about 3,100 gpd/ft^2. The overall average hydraulic conductivity using both observation wells and the test production well data is about 3,625 gpd/ft^2.

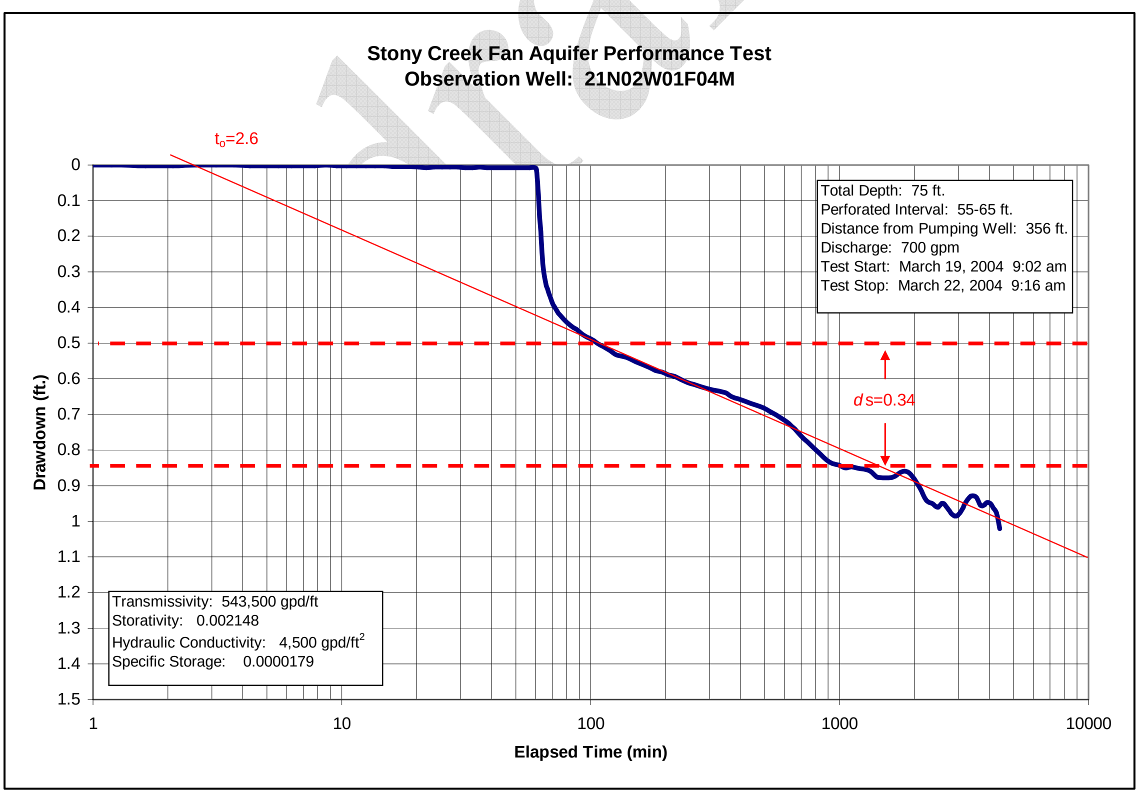


Figure 6. Observation Well 21N02W01F04M: Drawdown vs. Time

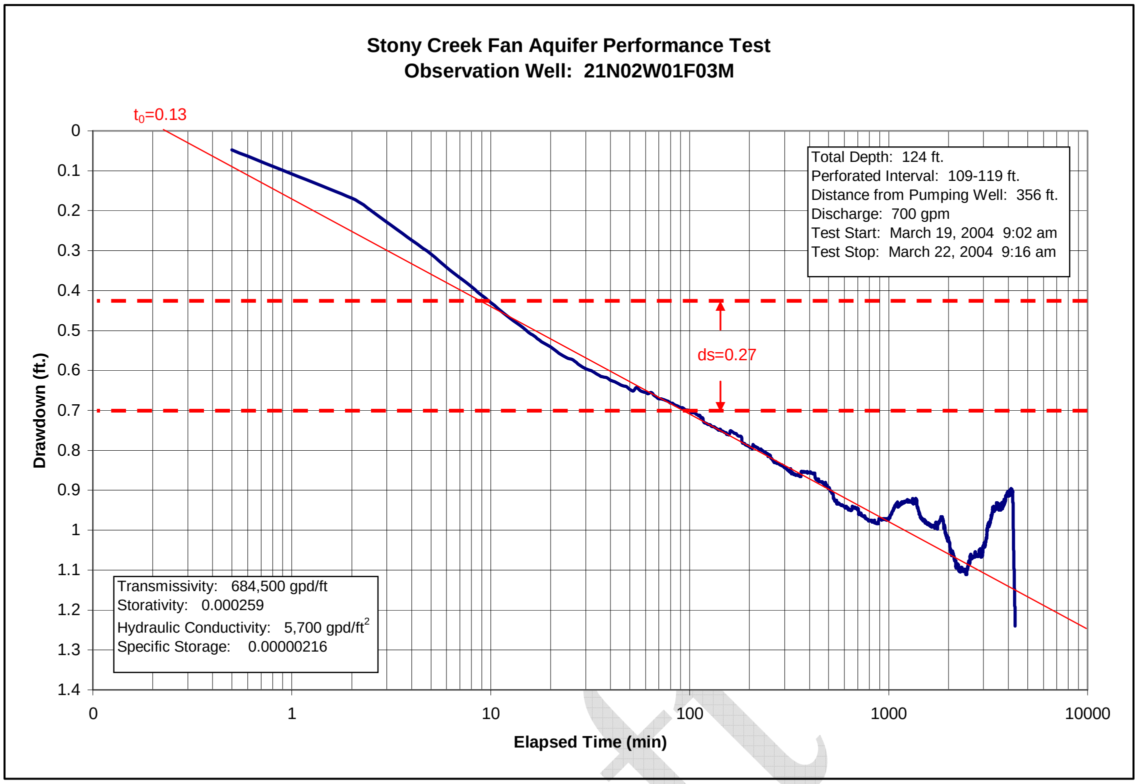


Figure 7. Observation Well 21N02W01F03M: Drawdown vs. Time

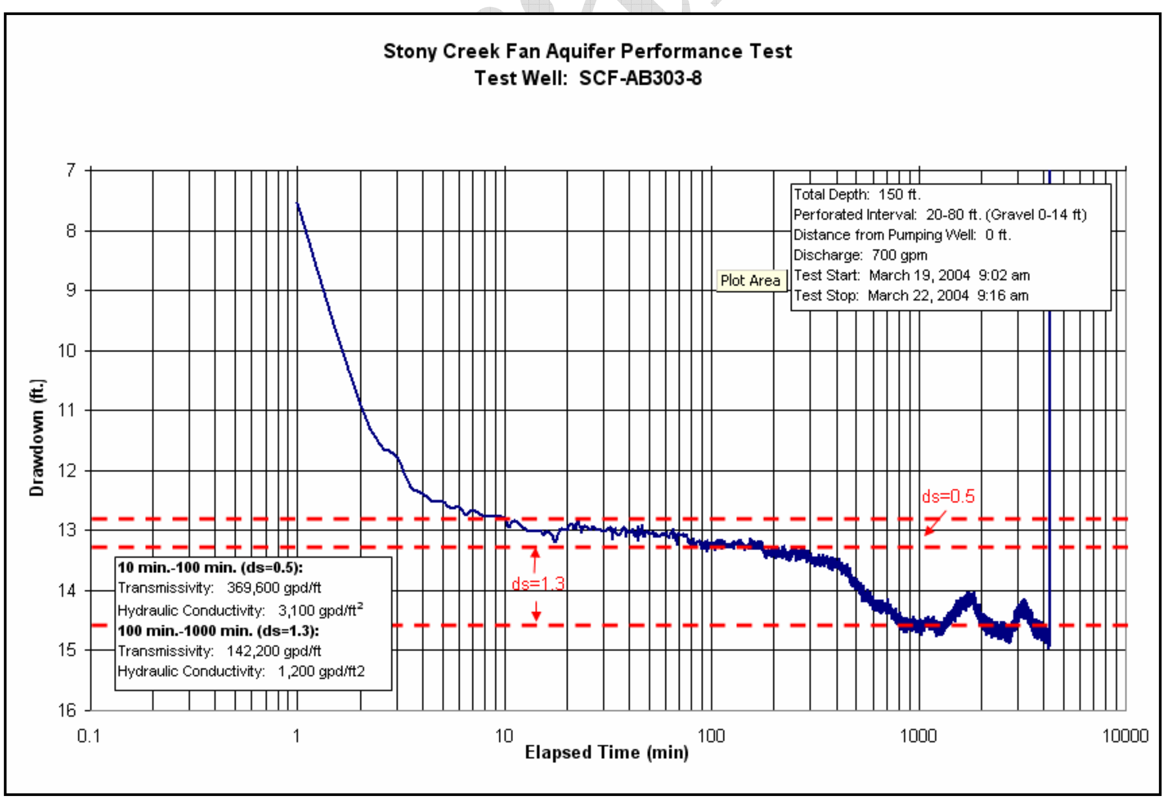


Figure 8. Test Production Well SCF-AB303-8: Drawdown vs. Time

Groundwater Levels.

Groundwater level data collected suggest that wells within one-half mile radius of the test production well were influenced by the test production well during operation. Table 2 shows that the maximum groundwater level decline was about 1.14 feet during the test. Groundwater levels in these wells returned to within one-half foot of the pre-test levels after the test production well pump was turned off. Wells over one-half mile from the test production well showed influence from irrigation wells outside the study area, in addition to one well that operated intermittently within the immediate study area. Table 2 also shows the distance from the test production well to the wells that were monitored and a summary of each of the well's construction information, if known.

Of the monitored wells with pumps installed in the study area, the St. John and Borba irrigation wells were not turned on during the test, although they began operating immediately afterward. Well 21N02W02K01M (02K01M) pumped intermittently throughout and after the constant discharge test, as did two irrigation wells 1,500 to 2,000 feet north and northeast of well 21N02W02B01M (02B01M), just outside the study area. Hydrographs are presented at the end of this report depicting groundwater levels before, during and after the aquifer performance test.

Well ID	Distance from Test Production Well (ft)	Maximum Drawdown (ft)	Top Perfor-ation (ft)	Bottom Perfor-ation (ft)	Total Depth (ft)	Comments
01F01M	366	0.03	547	557	578	
01F02M*	366	1.12	297	307	318	
01F03M	356	1.07	109	119	124	
01F04M	356	1.06	55	65	75	
02B01M**	4931	4.83	unknown	unknown	200	No log.
02K01M***	4682	1.00	25	300	303	
36D01M	7208	0.37	unknown	unknown	100	No log.
Borba Ag.	614	1.02	50	285	400	
Borba Dom.	2851	1.14	44	132	150	
St. John East	2451	0.84	100	240	372	
St.John West	3540	0.67	118	362	390	
Test Production Well	0	14.85	20	80	140	

*This well historically shows a correspondence to surrounding irrigation wells also pumping from this zone.

**An irrigation well across the road from 02B01M was operating throughout the test.

***Well 02K01M turned on and off throughout the test.

Table 2. Distance from Pumping Well, Drawdown, and Well Construction Data.

Water Quality.

Water quality samples were taken in the field using a portable water quality unit. Temperature, pH and electrical conductivity were measured five days prior to testing, and on the second and third days of the constant discharge test. These results are shown on Table 3. The initial water temperature reading on the first day of testing was 65.66 °F. By the second day of testing, the temperature had increased slightly to 65.84 °F. On the last day of the test, the water temperature had decreased by about two and a half degrees to 63.32 °F. This decrease suggests a possible recharge boundary from either Stony Creek (approximately one mile northeast of the test location) or the Sacramento River (approximately 3.3 miles east of the test location).

The pH started at 7.3 and rose to 7.54 over the three-day test, which is within the normal range for groundwater. The electrical conductivity dropped from 657 micromhos to 596 micromhos over the course of the sampling, typical for groundwater being extracted over time.

Date/Time	Temperature °F	pH	Electrical Conductivity (micromhos)
3/15/04 17:00	65.66	7.3	657
3/20/04 17:43	65.84	7.38	615
3/21/04 16:50	63.32	7.54	596

Table 3. Water Quality Parameters Taken During Testing.

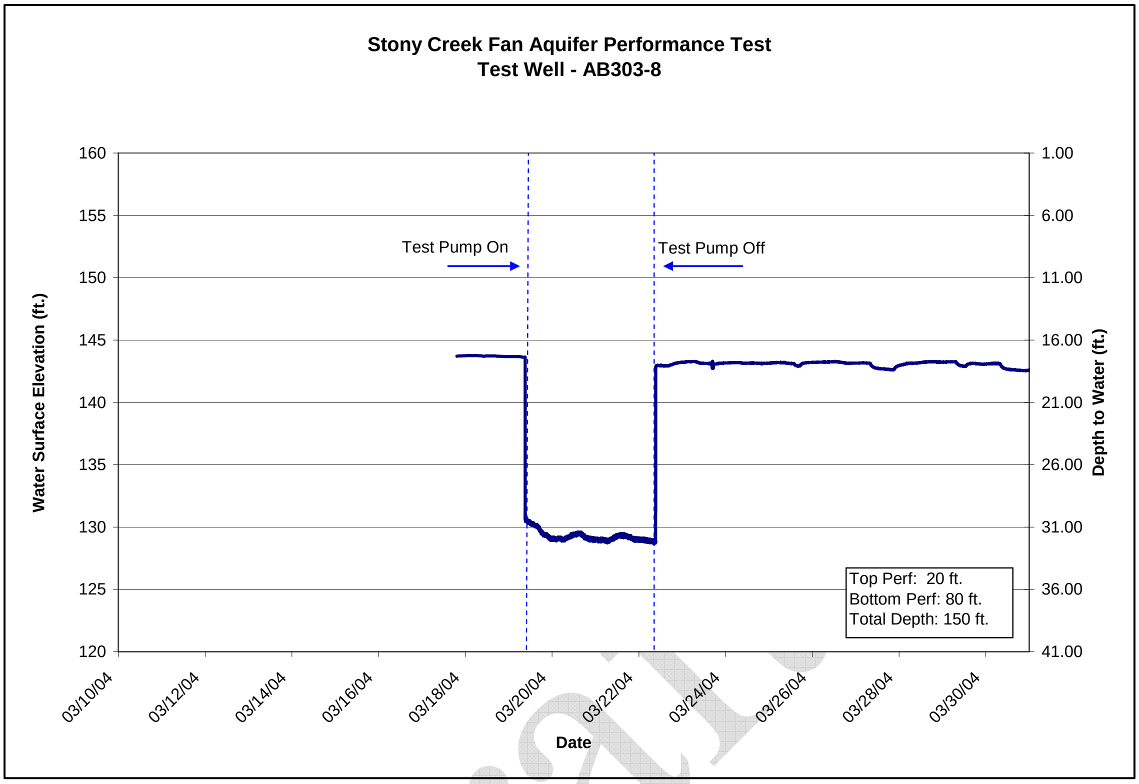
Summary

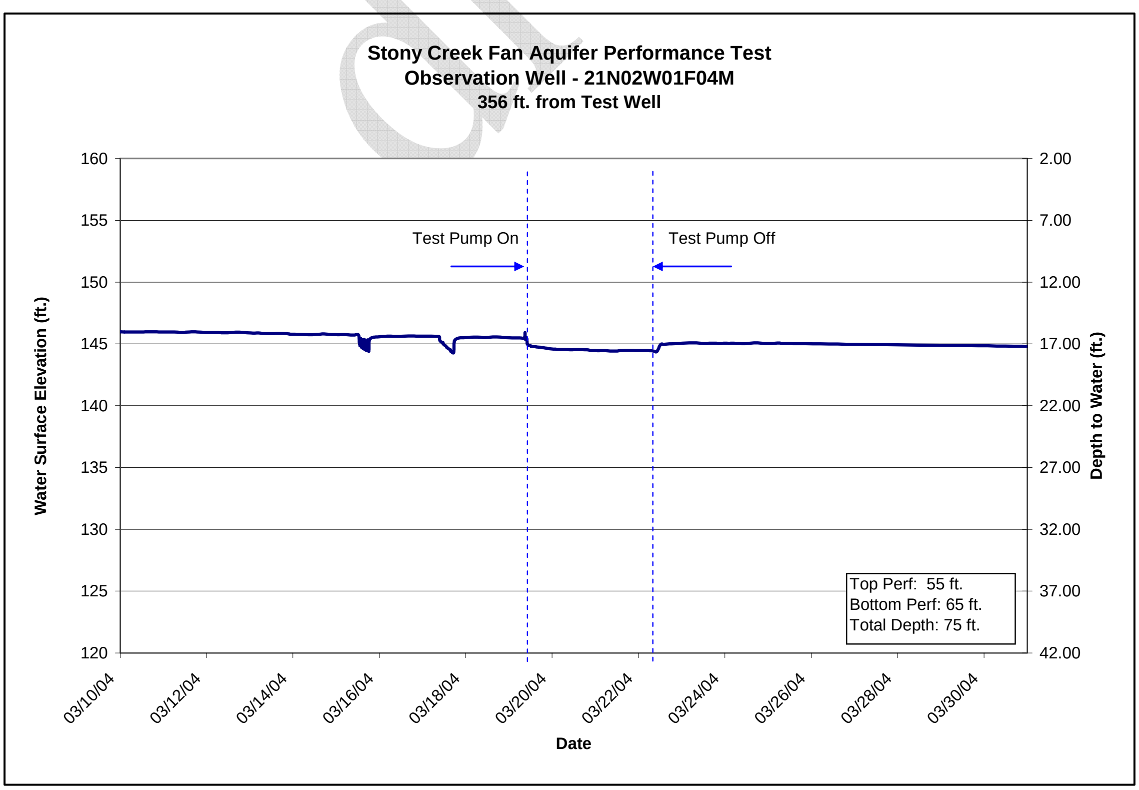
An aquifer performance test was performed on the Stony Creek Fan aquifer system from March 19 to March 22, 2004, to determine the transmissivity, storativity and hydraulic conductivity of the aquifer. Transmissivity of the Stony Creek Fan aquifer averaged 406,525 gpd/ft, with storativity values ranging from 0.002148 to in the upper zone to 0.000259 in the lower zone. Hydraulic conductivity averaged 3,625 gpd/ft^2 in the Stony Creek Fan sediments.

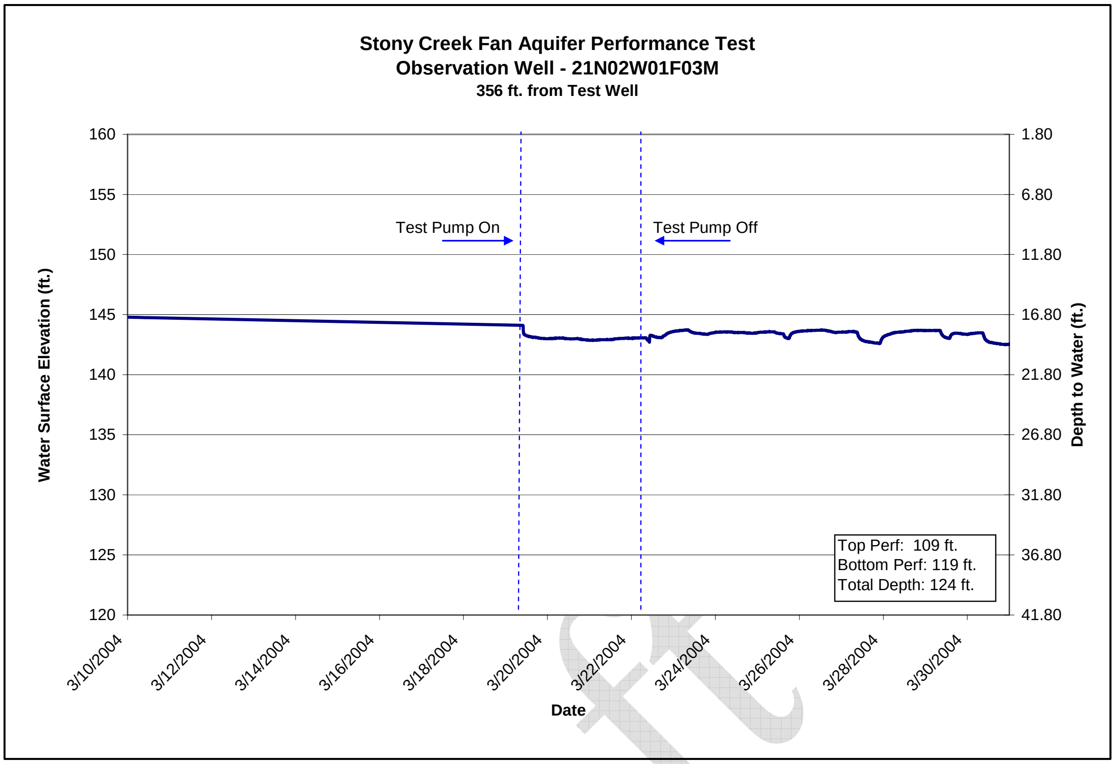
Groundwater levels taken before, during and after the test indicate that wells within a one-half mile radius of the test production well were influenced by the test production well, while wells located over one-half mile from the test production well showed influence from other irrigation wells pumping inside and outside the study area.

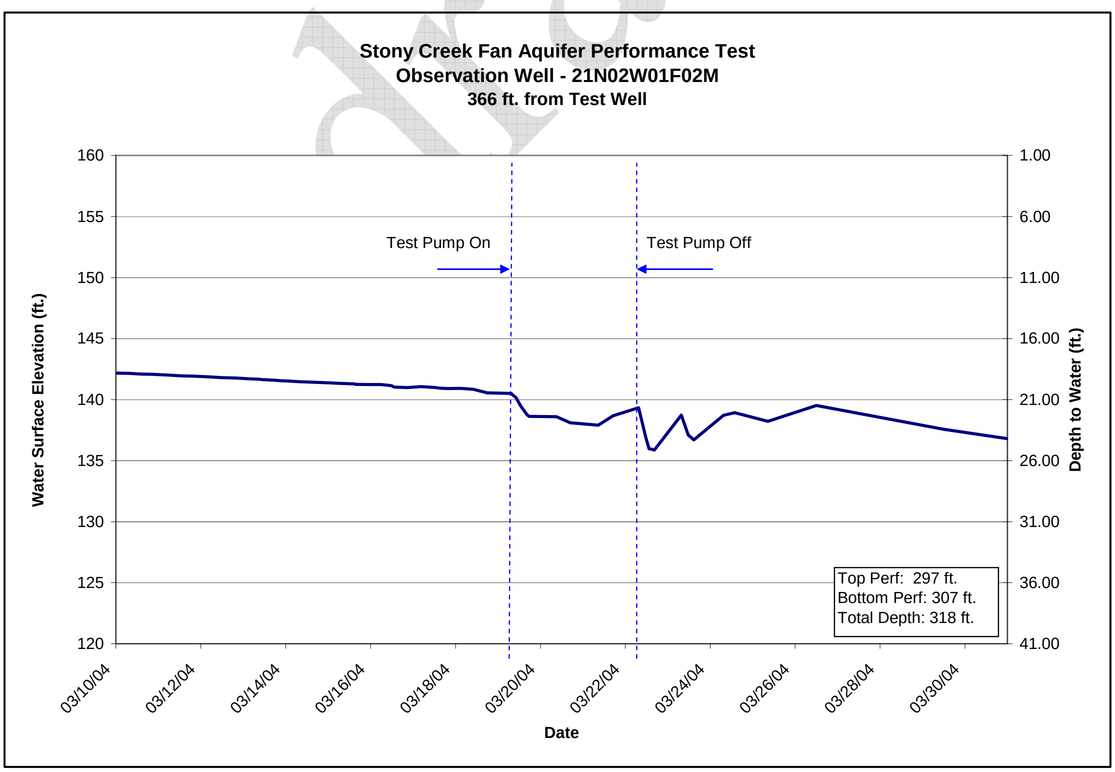
Water quality samples indicate that the water temperature decreased from 65.66 °F to 63.32 °F indicating a possible recharge boundary. The hydrogen ion concentration (pH) rose from 7.3 to 7.54, and the electrical conductivity dropped from 657 micromhos to 596 micromhos, typical for groundwater being pumped over time.

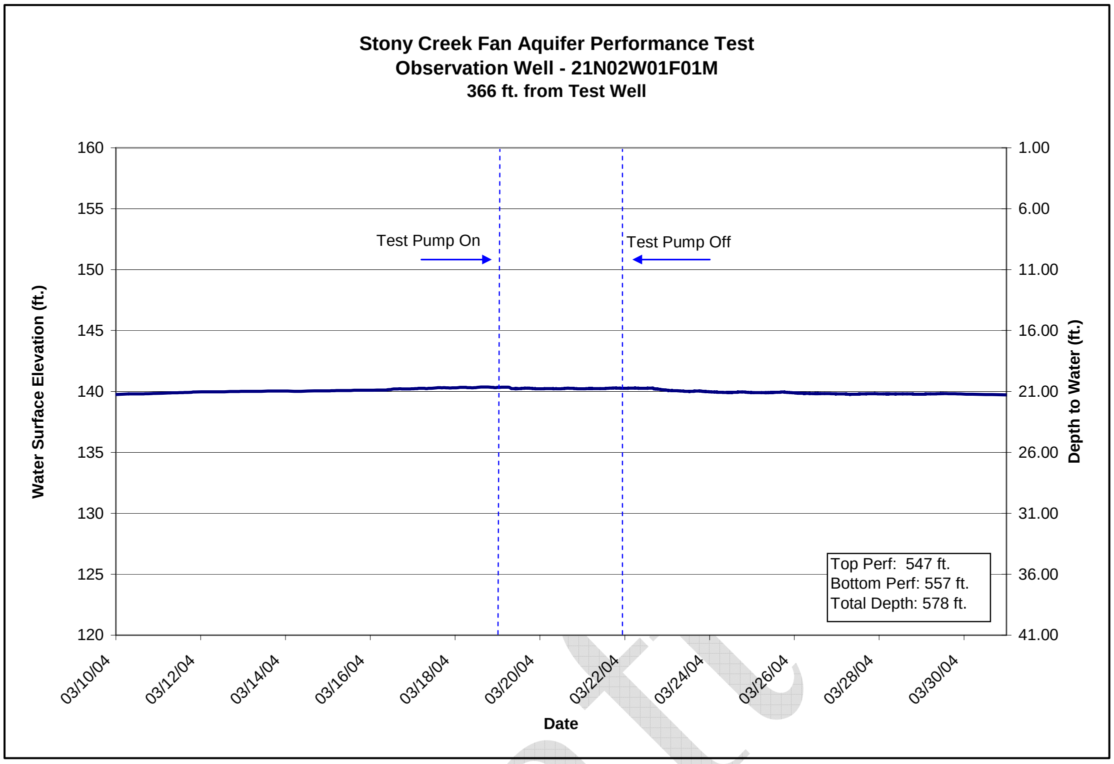
Groundwater Level Hydrographs

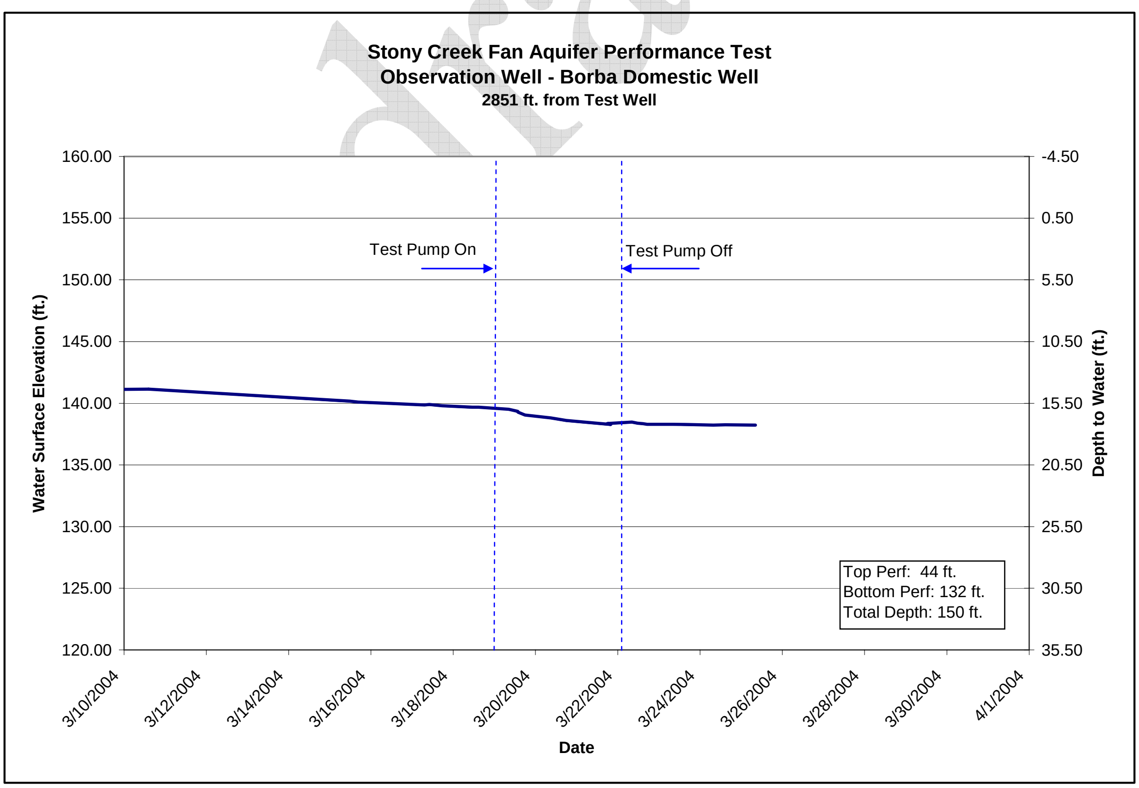


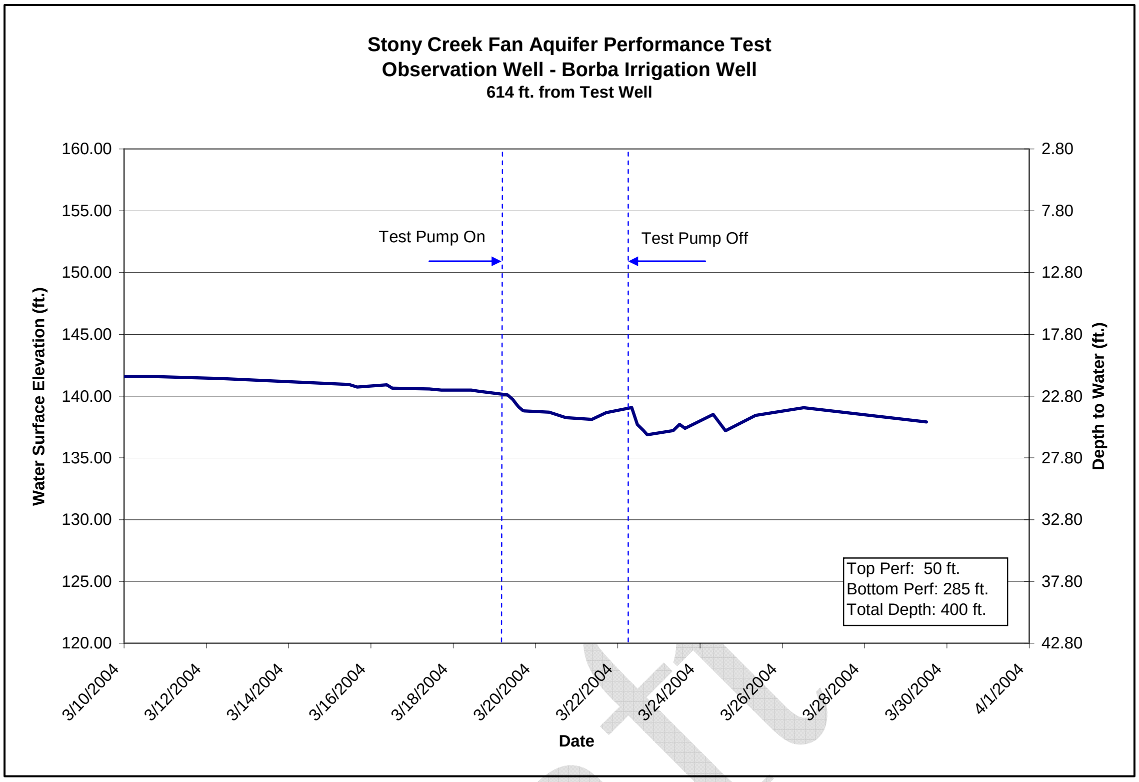


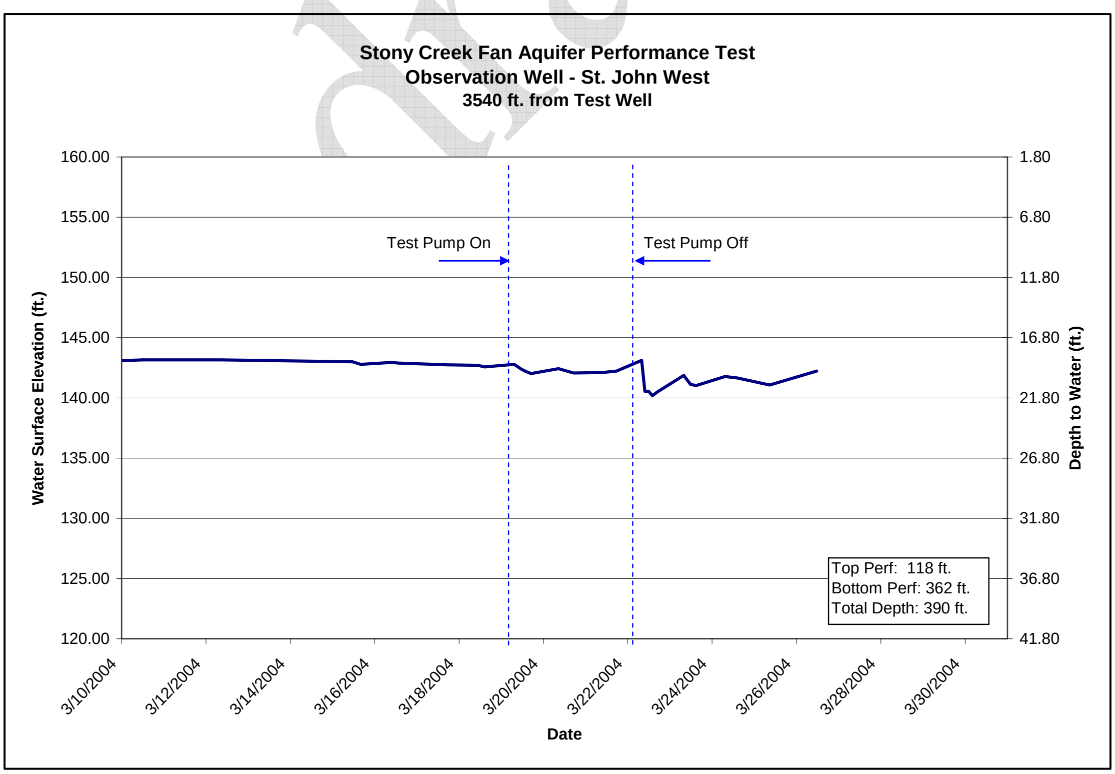

Stony Creek Fan Aquifer Performance Test
Observation Well - 21N02W01F03M
356 ft. from Test Well
Test Pump On
Test Pump Off
Water Surface Elevation (ft.)
Depth to Water (ft.)
160
155
150
145
140
135
130
125
120
1.80
6.80
11.80
16.80
21.80
26.80
31.80
36.80
41.80
Top Perf: 109 ft.
Bottom Perf: 119 ft.
Total Depth: 124 ft.
3/10/2004
3/12/2004
3/14/2004
3/16/2004
3/18/2004
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
Date

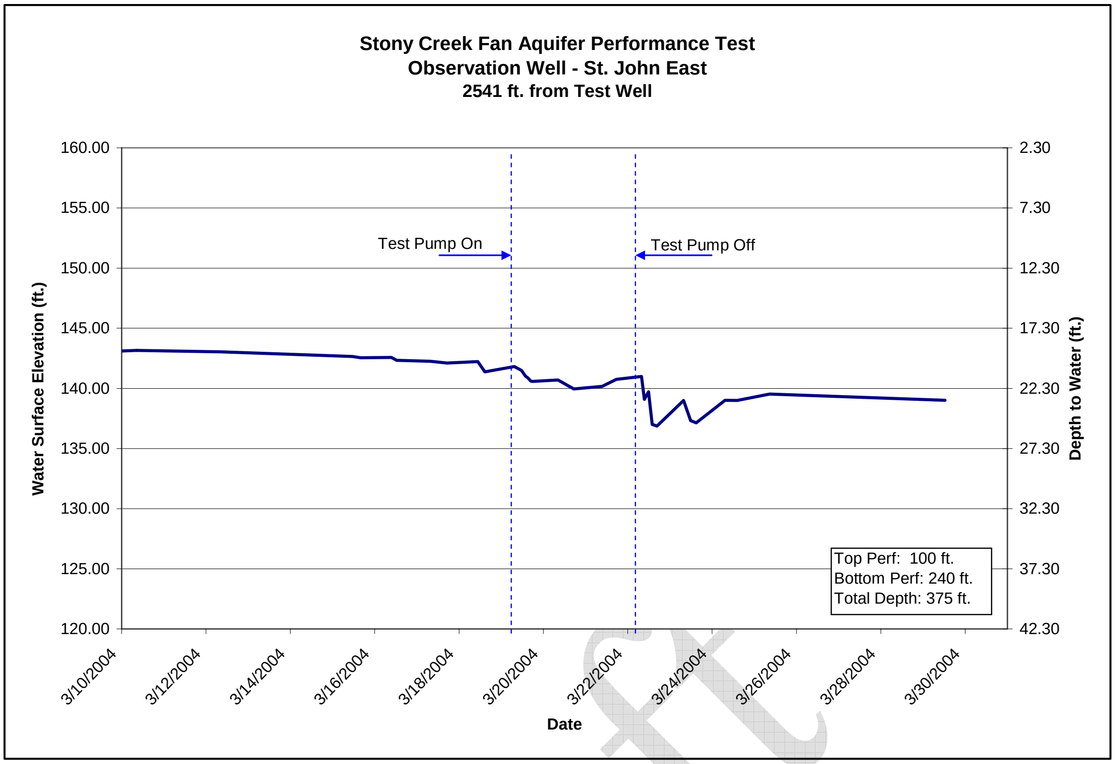

Stony Creek Fan Aquifer Performance Test
Observation Well - 21N02W01F02M
366 ft. from Test Well
Test Pump On
Test Pump Off
Water Surface Elevation (ft.)
Depth to Water (ft.)
160
155
150
145
140
135
130
125
120
1.00
6.00
11.00
16.00
21.00
26.00
31.00
36.00
41.00
Top Perf: 297 ft.
Bottom Perf: 307 ft.
Total Depth: 318 ft.
03/10/04
03/12/04
03/14/04
03/16/04
03/18/04
03/20/04
03/22/04
03/24/04
03/26/04
03/28/04
03/30/04
Date


Stony Creek Fan Aquifer Performance Test
Observation Well - 21N02W01F01M
366 ft. from Test Well
Test Pump On
Test Pump Off
Water Surface Elevation (ft.)
Depth to Water (ft.)
160
155
150
145
140
135
130
125
120
1.00
6.00
11.00
16.00
21.00
26.00
31.00
36.00
41.00
Top Perf: 547 ft.
Bottom Perf: 557 ft.
Total Depth: 578 ft.
03/10/04
03/12/04
03/14/04
03/16/04
03/18/04
03/20/04
03/22/04
03/24/04
03/26/04
03/28/04
03/30/04
Date

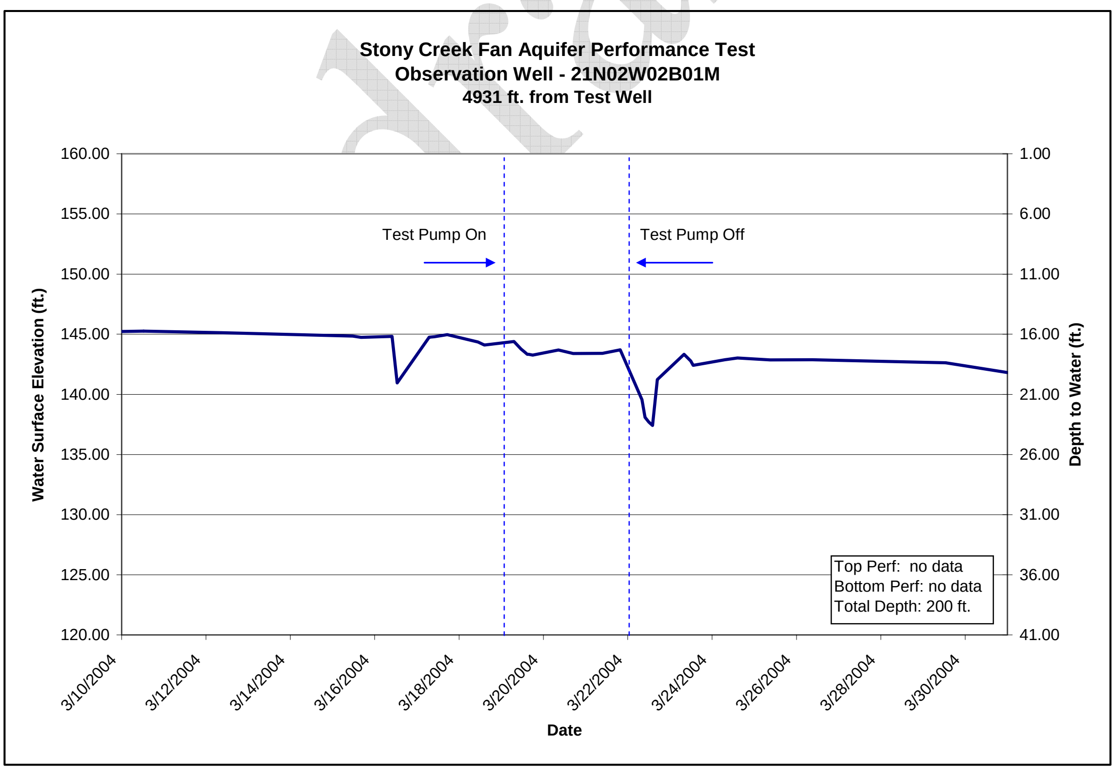

Stony Creek Fan Aquifer Performance Test
Observation Well - Borba Domestic Well
2851 ft. from Test Well
Test Pump On
Test Pump Off
Water Surface Elevation (ft.)
Depth to Water (ft.)
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
-4.50
0.50
5.50
10.50
15.50
20.50
25.50
30.50
35.50
Top Perf: 44 ft.
Bottom Perf: 132 ft.
Total Depth: 150 ft.
3/10/2004
3/12/2004
3/14/2004
3/16/2004
3/18/2004
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
4/1/2004
Date


Stony Creek Fan Aquifer Performance Test
Observation Well - Borba Irrigation Well
614 ft. from Test Well
Test Pump On
Test Pump Off
Top Perf: 50 ft.
Bottom Perf: 285 ft.
Total Depth: 400 ft.
Water Surface Elevation (ft.)
Depth to Water (ft.)
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
2.80
7.80
12.80
17.80
22.80
27.80
32.80
37.80
42.80
3/10/2004
3/12/2004
3/14/2004
3/16/2004
3/18/2004
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
4/1/2004
Date

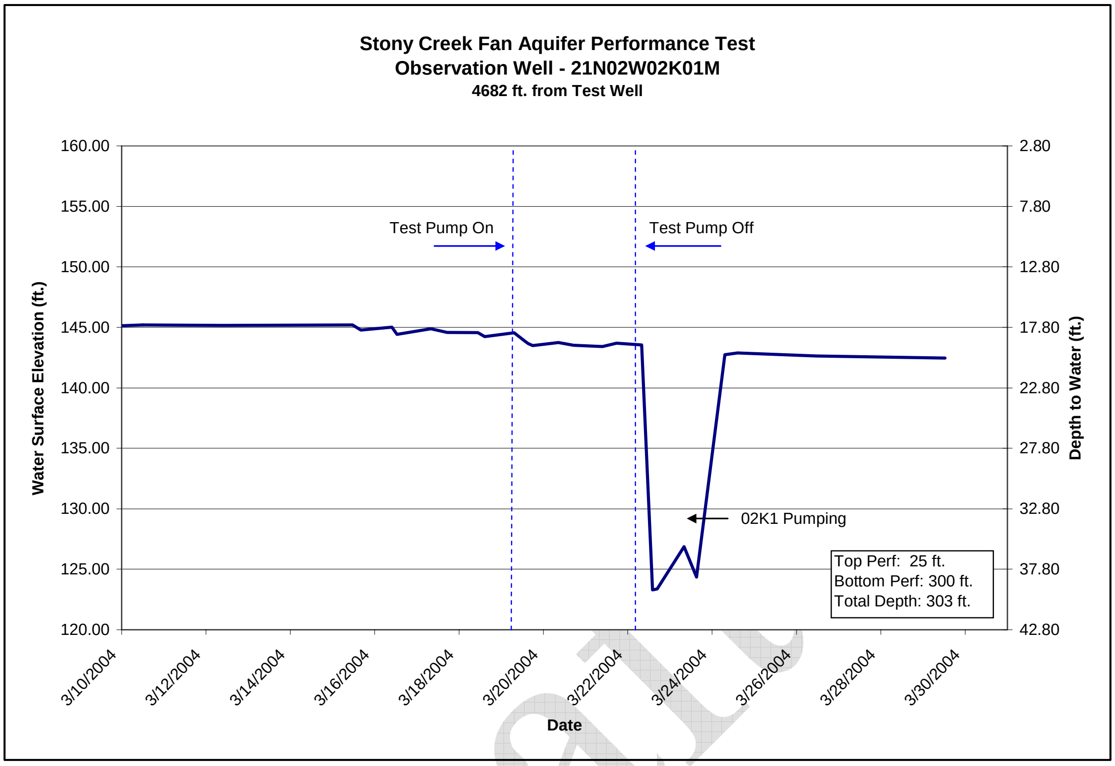

Stony Creek Fan Aquifer Performance Test
Observation Well - St. John West
3540 ft. from Test Well
Test Pump On
Test Pump Off
Top Perf: 118 ft.
Bottom Perf: 362 ft.
Total Depth: 390 ft.
Water Surface Elevation (ft.)
Depth to Water (ft.)
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
1.80
6.80
11.80
16.80
21.80
26.80
31.80
36.80
41.80
3/10/2004
3/12/2004
3/14/2004
3/16/2004
3/18/2004
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
Date



Stony Creek Fan Aquifer Performance Test
Observation Well - St. John East
2541 ft. from Test Well
Water Surface Elevation (ft.)
Depth to Water (ft.)
Test Pump On
Test Pump Off
Top Perf: 100 ft.
Bottom Perf: 240 ft.
Total Depth: 375 ft.
Date



Stony Creek Fan Aquifer Performance Test
Observation Well - 21N02W02B01M
4931 ft. from Test Well
Water Surface Elevation (ft.)
Depth to Water (ft.)
Test Pump On
Test Pump Off
Top Perf: no data
Bottom Perf: no data
Total Depth: 200 ft.
Date


Stony Creek Fan Aquifer Performance Test
Observation Well - 21N02W02K01M
4682 ft. from Test Well
Water Surface Elevation (ft.)
Depth to Water (ft.)
Test Pump On
Test Pump Off
02K1 Pumping
Top Perf: 25 ft.
Bottom Perf: 300 ft.
Total Depth: 303 ft.
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
2.80
7.80
12.80
17.80
22.80
27.80
32.80
37.80
42.80
3/10/2004
3/12/2004
3/14/2004
3/16/2004
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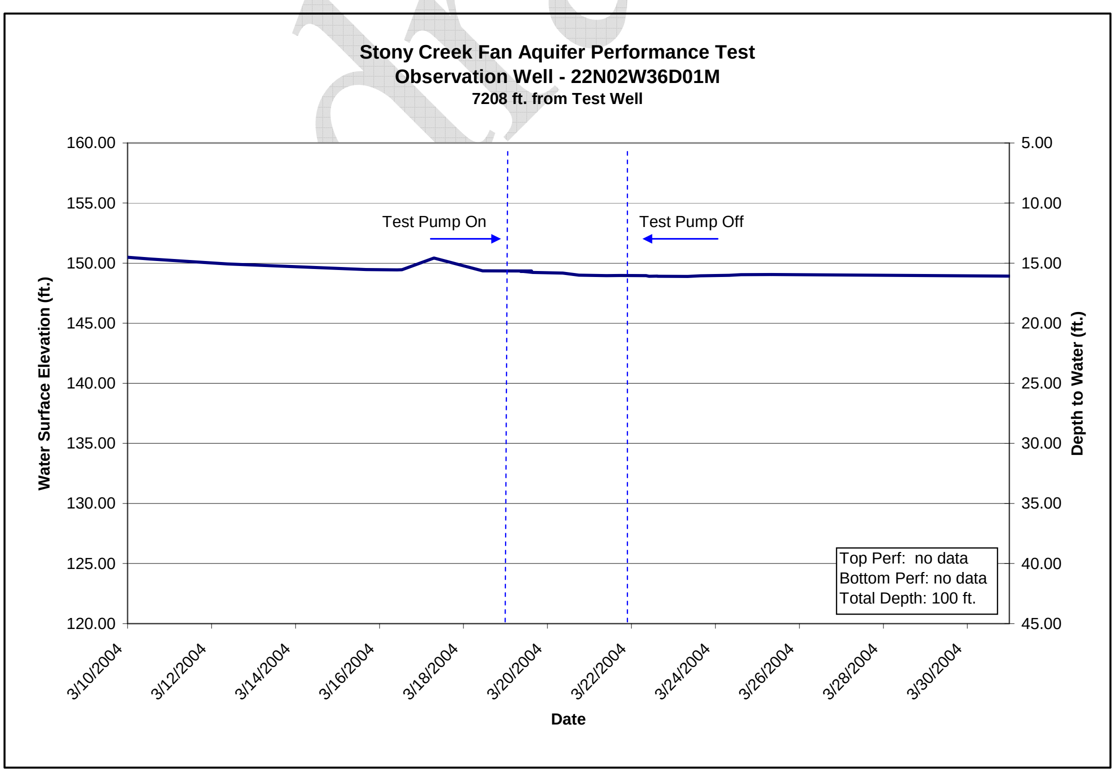
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
Date


Stony Creek Fan Aquifer Performance Test
Observation Well - 22N02W36D01M
7208 ft. from Test Well
Water Surface Elevation (ft.)
Depth to Water (ft.)
Test Pump On
Test Pump Off
Top Perf: no data
Bottom Perf: no data
Total Depth: 100 ft.
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
3/10/2004
3/12/2004
3/14/2004
3/16/2004
3/18/2004
3/20/2004
3/22/2004
3/24/2004
3/26/2004
3/28/2004
3/30/2004
Date