Buckman Well 10-13 Monitoring Program: Semiannual and Biennial Report February 2009

1.0 Introduction

This report summarizes the production and water-level changes of the City of Santa Fe's Buckman Well Field, with a particular focus on the four new supplemental wells, Buckman Wells 10, 11, 12, and 13 (BW10-13), completed in 2003 (Figure 1). Buckman wells 1 through 9 are permitted under New Mexico Office of the State Engineer file number RG-20516 through RG-20516-S-9, and Buckman wells 10 through 13 are permitted under OSE file numbers RG-20516-S-10 through RG-20516-S-13. As required by permit condition for BW10-13 specified within the 'Buckman Well Field Water-Level Monitoring Program' (Monitoring Program), this report fulfills the City of Santa Fe's (City) requirement to submit both semi-annual and biennial reports to the New Mexico Office of the State Engineer (NMOSE). A copy of the Monitoring Program can be downloaded from the City Water Division's web site at http://www.santafenm.gov/index.asp?NID=1030. This report is, in part, designed to allow area well owners and the general public to more readily understand the effects of pumping the supplemental Buckman wells on the aquifer.

The City's production and water-level data summarized in this report are available in two Microsoft Excel spreadsheets 'BW RG20516 prod and wtr lvl 1981 to 2008.xls' and 'USGS Buckman Area GWater Level Data.xls', available on the City Water Division's web, http://www.santafenm.gov/index.asp?NID=1030 and have not, therefore, been appended to this report. The spreadsheets contain:

1. Buckman Well Field production data, monthly from 1981 through December 2008 and daily from January 2006 through December 2008
2. water-level data collected by the City municipal water utility and collected by the U.S. Geological Survey (USGS) for the Buckman area,
3. graphs of ground-water-level changes over time.

The information on the Monitoring Program can also be reached by following the links beginning at the City's home page: www.santafenm.gov → Government → Departments → Public Utilities → Water Division → Water Resources → Buckman Wells Monitoring Program.

2.0 Production from RG-20516 (Buckman Well Field)

Since 2003, when the BW10-13 first began producing water for the municipal utility, the City has pumped between 3,532 and 5,997 acre-feet (ac-ft) per year from the Buckman Well Field (Table 1). Of the total Buckman Well Field production over the past six years, 31 percent has come from BW10-13, with the annual percentage ranging from 10 to 59 percent.

Table 1: Summary of Buckman Well field Production

Year	Annual Total Production: Buckman Well Field	Annual Total Production: Buckman Wells 10-13	Production from Buckman Wells 10-13
	ac-ft	ac-ft	percent
2003	5825.1	570.8	10

2004	5997.0	3555.7	59
2005	3784.3	767.2	20
2006	5197.1	1977.0	38
2007	3793.6	795.8	21
2008	3532.4	930.1	26
Total	*28129.4*	*8596.7*	*31*

The top three individual Buckman production wells for each year are identified in Table 2.

Table 2: Top Production Wells, Annually

Year	Top Three Individual Producing Wells	Annual Production, respectively, in ac-ft
2003	BW6, BW7, BW7	1188, 987, 780
2004	BW13, BW12, BW6	1358, 1030, 961
2005	BW7, BW8, BW4	1223, 797, 510
2006	BW6, BW11, BW8	1077, 825, 814
2007	BW8, BW7, BW4	704, 704, 567
2008	BW8, BW7, BW5	817, 773, 743

Under NMOSE RG-20516 et al. permit, the City is permitted to pump 6,000 ac-ft annually from the Buckman 10-13 supplemental wells. Annual production from individual BW10-13 is summarized in Table 3.

Table 3: Annual Production from Buckman Wells 10-13.

Year	BW10	BW11	BW12	BW13	BW10-13
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
2003	0.0	251.2	259.5	60.1	570.8
2004	457.8	710.8	1029.6	1357.5	3555.7
2005	22.8	367.9	216.3	160.2	767.2
2006	656.5	824.7	88.4	407.4	1977.0
2007	222.5	136.9	31.5	404.8	795.8
2008	262.7	541.0	42.2	84.3	930.1
Total	***1622.4***	***2832.6***	***1667.4***	***2474.4***	***8596.7***

3.0 WATER-LEVEL TRENDS

To monitor the effects of producing water from the Buckman Well Field on the aquifer, water-level data has been collected in the region for over 30 years as a NMOSE RG-20516 et al. permit requirement. The water-level monitoring program was expanded with the permitting of supplemental BW10-13. At the request of NMOSE staff in a meeting on October 15, 2008, the focus of this report is on water-level changes that have occurred since the BW10-13 came online in October 2003. All of the trends presented below, in Table 4, and in Figure 4 are focused on the post-October 2003 time period. Positive numbers indicate a water level rise and negative numbers represent a water level decline for the calculated rate of change in Table 4. As noted in Section 1.0, all data used in this report is available on the City's website.

Under the current Monitoring Program, water levels are or will be measured at various frequencies in each of the following:

- All of the City's thirteen production wells (BW1-13) under permit RG-20516,
- US Geological Survey (USGS) and other monitoring wells: SF2A, SF2B, SF2C, SF3A, SF3B, SF3C, SF4A, SF4B, SF4C, SF5C, Buckman (also known as SF6 and Devil's Throne; shallow, middle and deep), Las Campanas (shallow, middle and deep), and a 1200-foot City monitoring well that has not yet been drilled,
- Private wells: RG-439 (Weil Corral), RG-16681 (Permit Well), RG-21318 (Skillet well), RG-30777, RG-6386, RG-29524, RG-25463, RG-24584, RG-438, RG-29723, and one yet unidentified 'active' domestic well within 2 miles of either BW12 or BW13.

More details on the nature and frequency of the water-level monitoring program are included in the Monitoring Program.

Because of difficulty in identifying, reaching, and obtaining access agreements or finding suitable wells, not all monitoring program wells identified above have been measured. An alternative monitoring point will need to be substituted for RG-24584, pending NMOSE's concurrence, because permission to measure the water level in well RG-24584 was not granted by the owner. An 'active' domestic well that is close to BW12 or BW13, has a year-round resident land owner, is not completed in an underground vault and is willing to have a transducer installed in their well has not yet been identified. The 1200-foot City monitoring well has not yet been drilled, but land access and easement agreements for the monitoring well are currently being negotiated with the La Tierra Homeowner's Association.

An analysis of maximum impacts was conducted during the BW10-13 NMOSE permit application. The analysis assumed that each BW10-13 would produce 1,500 ac-ft/yr for 100 years. The amount actually pumped to date is 8,957 ac-ft versus the 31,500 ac-ft permitted through 2008; hence the projected water-level change impacts due to actual pumping are significantly less than projected in the permit application. For this report, the City did not conduct ground-water modeling to separate the water-level changes induced by BW10-13 pumping effects from the regional water-level changes. In Finding 27 of NMOSE Hearing 03-004 (BW10-12), the hearing examiner accepted testimony from NMOSE hydrologist Andy Core that regional water-level changes prior to the granting of and the pumping from the BW10-13 well permit range from 0.89 feet per year (ft/yr) rise and 7.41 ft/yr decline with an average of 1.18 ft/yr decline.

3.1 Production wells

The water-level trend in twelve of the thirteen Buckman wells has been rising since October 2003, at rates ranging from 2 to 48 ft/yr (last column, Table 4). The average water level in Buckman Well 11 has remained steady since the well began producing water in October 2003. The straight line approximation used for calculating the rates of change are indicated by dashed lines in the hydrographs for each of the wells in the Excel spreadsheet 'BW RG20516 prod and wtr lvl 1981 to 2008.xls'. For Buckman Wells 1-9, where the period of record is longer than the timeframe of interest for this report, the dashed lines have been approximated visually by comparing water levels that best represent the non-pumped condition. For Buckman Wells 10-13, the dashed line was fitted using a linear best fit function in Excel. Figure 2 illustrates how the water-level change rates in the Buckman wells (in blue) are geographically distributed.

Table 4. Water-Level Data for Monitoring Program Area Wells

OSE id	NMBGMR or USGS id	Name	Total Well Depth	Initial water level (1) = pumping		Period of Record		Most Recent Water Level		Total Change since 10/2003	Rate of Change 10/2003-12/2008
					ft bgl	period	# of years	date	ft bgl		ft/yr
1	355000106092801	SF-2A	1836	03/11/1987	-127.3	1987-1999	12	11/12/1999	29.4	inaccessible	NA
2	355000106092802	SF-2B	824	07/29/1986	137.8	1986-2008	22	08/05/2008	166.4	238.2	47.6
3	355000106092803	SF-2C	346	07/29/1986	119.5	1986-2008	22	08/05/2008	152.9	81.5	16.3
4	355002106093701	SF-3A	294	01/15/1988	39.0	1988-2008	20	08/05/2008	105.5	81.1	16.2
5	355002106093702	SF-3B	169	01/15/1988	5.0	1988-2008	20	08/05/2008	11.8	5.0	1.0
6	355002106093703	SF-3C	60	01/15/1988	15.7	1988-2008	20	08/05/2008	17.3	0.5	0.1
7	355003106094301	SF-4A	280	01/15/1988	26.9	1988-2008	20	08/05/2008	92.6	63.4	12.7
8	355003106094302	SF-4B	130	01/15/1988	-0.3	1988-2008	20	08/05/2008	3.5	2.2	0.4
9	355003106094303	SF-4C	60	01/15/1988	11.3	1988-2008	20	08/05/2008	12.4	0.7	0.1
10	355006106094803	SF-5C	69	01/15/1988	4.9	1988-2008	20	08/05/2008	5.2	0.8	0.2
11	354731106072001	Buckman Deep	2440	10/24/2003	59.9	2003-2008	5	08/05/2008	155.6	-95.7	-19.1
12	354731106072002	Buckman Middle	1340	10/24/2003	164.8	2003-2008	5	08/05/2008	194.9	-30.1	-6.0
13	354731106072003	Buckman Shallow	480	10/24/2003	186.6	2003-2008	5	08/05/2008	196.7	-10.1	-2.0
14	354228106044901	Las Campanas Deep Piezo.	1990	07/06/2005	216.5	2005-2008	3	08/05/2008	216.9	-0.4	-0.1
15	354228106044902	Las Campanas Middle Piezo.	1320	07/06/2005	262.7	2005-2008	3	08/05/2008	254.9	7.8	2.6
16	354228106044903	Las Campanas Shallow Piezo.	450	07/06/2005	278.7	2005-2008	3	08/05/2008	279.2	-0.5	-0.2
17 RG-20516 et al		Buckman 1	1093	10/31/1982	76.0	1982-2008	26	12/31/2008	313.3	53.0	10.6
18 RG-20516 et al		Buckman 2	1473	10/31/1982	54.0	1982-2008	26	12/31/2008	121.0	239.0	47.8
19 RG-20516 et al		Buckman 3	1490	10/31/1982	7.3	1982-2008	26	06/30/2008	335.0	190.0	38.0
20 RG-20516 et al		Buckman 4	1182	07/31/1987	26	1986-2008	22	12/31/2008	556.0 (1)	138.0	27.6
21 RG-20516 et al		Buckman 5	1154	10/31/1982	45.7	1982-2008	26	12/31/2008	521.3 (1)	166.0	33.2
22 RG-20516 et al		Buckman 6	1410	10/31/1982	59.5	1982-2008	26	08/31/2008	334.0	206.0	41.2
23 RG-20516 et al		Buckman 7	1409	06/30/1991	236	1991-2008	17	12/31/2008	305.7	94.0	18.8
24 RG-20516 et al		Buckman 8	910	06/30/1991	47	1991-2008	17	12/31/2008	412.1	33.0	6.6
25 RG-20516 et al		Buckman 9	1320	11/30/2003	669.5	2003-2008	5	12/31/2008	357.4 (1)	45.0	9.0
26 RG-20516 et al		Buckman 10	1980	01/31/2004	496.5	2004-2008	4	12/31/2008	354.1	10.0	2.0
27 RG-20516 et al		Buckman 11	1900	10/31/2003	489.9 (1)	2003-2008	5	12/31/2008	520.0	0.0	0.0
28 RG-20516 et al		Buckman 12	1900	10/31/2003	642.9 (1)	2003-2008	5	12/31/2008	387.5 (1)	215.0	43.0
29 RG-20516 et al		Buckman 13	1980	01/31/2004	461.1	2004-2008	4	12/31/2008	317.1	75.0	15.0
37 RG-21318	EB288	Skillet	663	10/31/1982	111.3	1982-2008	26	12/31/2008	208.2	12.6	2.5
38 RG-439	EB157	Weil Corral	325	10/31/1982	74.0	1982-2008	26	12/31/2008	258.8	36.0	7.2
39 RG-7248	EB161	Boondock	900	10/31/1982	421.0	1982-2008	26	03/31/1994	470.0	NA	NA
40 RG-16681	EB163	Permit	745	10/31/1982	695.0	1982-2008	26	12/31/2008	695.4	-0.2	0.0
30 RG-6386	EB160	Tony's Windmill	350	11/21/1967	292	1967-2009	42	01/21/2009	293.57	-2.6	-0.5
31 RG-29524	EB085	Las Dos 1	773	10/29/1977	371.3	1977-2009	32	01/27/2009	389.9	-15.9	-22.0
32 RG-25463	EB287	Pinon-Bogle	841	01/21/1975	465.0	1975-2009	34	01/27/2009	468.72	-0.5	-0.1
~~33 RG-24584~~	~~EB121~~	~~Santa Fe Ranch (Daniels)~~	~~602~~	~~03/14/1975~~	~~425.8~~	~~1975-2003~~	~~28~~	~~07/23/2003~~	~~426.5~~	~~NA~~	~~NA~~
34 RG-438	EB251	Midway Windmill	310	06/30/1962	220	1962-2009	47	01/27/2009	267.28	-11.8	-2.2
35 RG-29723	-	USFS Well	681	04/03/2004	664.4			04/03/2004	664.4	NA	NA
36 RG-30777	EB064	Bernstein	644	09/21/1978	563.3	1978-2009	31	01/21/2009	544.96	18.3	-0.6

Water-level data in production wells must be interpreted cautiously, because the dynamic drawdown related to well efficiency that occurs when the well is pumping does not correlate to aquifer conditions. The monthly water-level measurements reflect varying periods of recovery or continuous pumping. Hence the dataset of water levels for a production well captures a range of conditions in the well, and should be interpreted as such.

3.2 USGS Monitoring Wells

During the period from October 2003 to December 2008, the water levels in ten of the sixteen USGS monitoring wells have been rising at rates ranging from 0.1 to 47.6 ft/yr (last column, Table 4). The water levels in five of the six USGS monitoring wells drilled north (Buckman) and south (Las Campanas) of BW10-13, have been declining at rates ranging from -0.1 to -19.1 ft/yr (Table 4). Of the three monitoring wells at Las Campanas, the shallow and the deep piezometers have been declining at a rates of -0.2 and -0.1 ft/yr, respectively (Table 4), significantly less than the presumed regional water-level decline rate in the area. The middle Las Campanas piezometer has been rising at a rate of 2.6 ft/yr (Table 4). All three monitoring wells at Buckman, in the heart of the newly configured well field, are declining, at -19.1 ft/yr (deep), -6.0 ft/yr (middle), and -2.0 ft/yr (shallow, Table 4). Figure 2 illustrates how the water-level change rate in the USGS monitoring wells (in green) are geographically distributed.

3.3 Private Wells

Most all private wells (domestic) are completed in the shallow portion of the aquifer. Eleven private wells included in the overall BW1-13 monitoring program contain existing water-level data (Table 4). Eight have recent water-level data relevant to this report. Of those eight wells, two show water-level rises in the range of 2.5 to 7.2 ft/yr, one shows no change in water level, and five show a decline of water levels ranging from -0.1 to -22.0 ft/yr. RG-30777, which is a good sentinel well for the private wells east of BW12 and BW13, has fluctuating water levels and shows no decisive water-level change trend. Rates of water-level changes in private wells were calculated by subtracting initial and final water-level measurements during the time period of interest, and divided the water-level change by the duration of change. Figure 2 illustrates how the water-level change rates in the private wells (in yellow) are geographically distributed.

4.0 Survey of Senior Wells in the Monitoring Program Area

The City has completed the arduous task of compiling a survey of the wells and well permits in the Monitoring Program area and the Tano Road Area, as delineated by Exhibit A of the Monitoring Program. The survey has identified 780 wells and well permits (Figure 3), many with NMOSE identification number, some without; many with verified well ownership and locations; some with initial water level and total well depth information from well records, some without. The final survey, 'Survey of wells and well permits in the Monitoring Program Area' can be viewed at the City web site identified in Section 1.0 of this report.

To identify the wells in the monitoring program area, the City hired John Shomaker & Associates, Inc. (JSAI) to compile all existing well data from known sources: the NMOSE WATERS database, a refinement of the WATERS database provided by NMOSE staff, New Mexico Bureau of Geology and Mineral Resources database, the USGS report by Mourant (1980), the USGS GWSI well database, the Santa Fe County Assessor property database, and City sources. Through a public information campaign, press releases, and meetings with

neighborhood leaders, the City and JSAI improved the accuracy of the well ownership and location information of the well survey. The City has been able to verify the information for wells identified by the squares in Figure 3. The City has not been able to verify information for the remaining wells and well permits. Although the City will no longer solicit additional well information, the City will update the survey should new well information become available to City Water Division staff.

The survey continues to contain significant inaccuracies, in terms of well locations and other information pertinent to the projection and mitigation requirements (Section 4.0) of the Monitoring Program. Initial water-level information or total well depth is missing for 15% of the wells. The City has little confidence that 77% of the wells are accurately located. Additionally, approximately 165 wells are likely from well permits that were never drilled.

5.0 Ten and Forty-year Projection of Water-Level Changes in the Monitored Wells

As agreed upon at the October 15, 2008, meeting with NMOSE staff, this report does not project ten and forty-year water-level changes in wells monitored under this monitoring program. The City will submit the projections with the 2010 biennial report, when additional sufficient data have been collected to warrant the projection.

6.0 Ten and Forty-year Projection of Water-Level Changes in the Surveyed Wells

As agreed upon at the October 15, 2008, meeting with NMOSE staff, this report does not project water-level changes for the private wells in the monitoring program area. The City will submit the projections with the 2010 biennial report, when additional sufficient data has been collected to warrant the projection.

7.0 Conclusion

This report meets the requirement identified in Section 3.3 of the Monitoring Program, modified according to discussions with the NMOSE staff during the October 15, 2008 meeting. BW10-13 production has been significantly less than analyzed in the permit application; subsequently, water-level declines have not followed those projected in the application's hydrologic analyses. Water-level changes in the monitoring program area do not follow a consistent trend of decline. In fact, from the time period of October 2003 through December of 2008, water levels have risen in a number of wells. A projection of water-level changes on private wells in the monitoring area was not done in this report; the available data, however, suggest that the past five years of pumping of BW10-13 has not significantly increased water-level declines beyond the average regional water-level decline of 1.18 ft/yr in most private wells within the monitoring program area. Additional water-level data collected before the 2010 biennial report will provide a better understanding of the impact that pumping BW10-13 is having on the aquifer as a whole, and on nearby private wells.

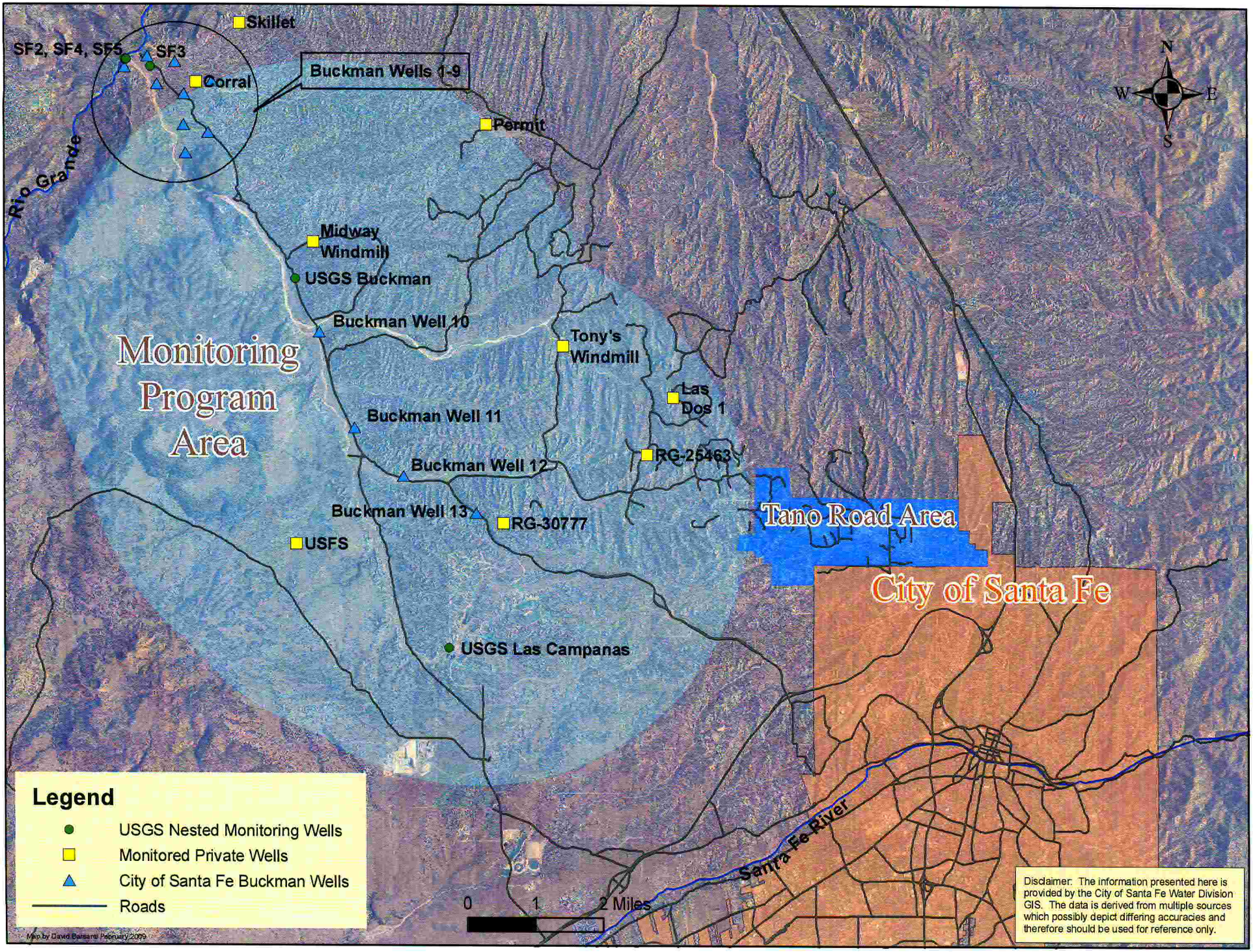

Figure 1: Buckman Wells 10-13 Monitoring Program Area and Monitoring Well Network

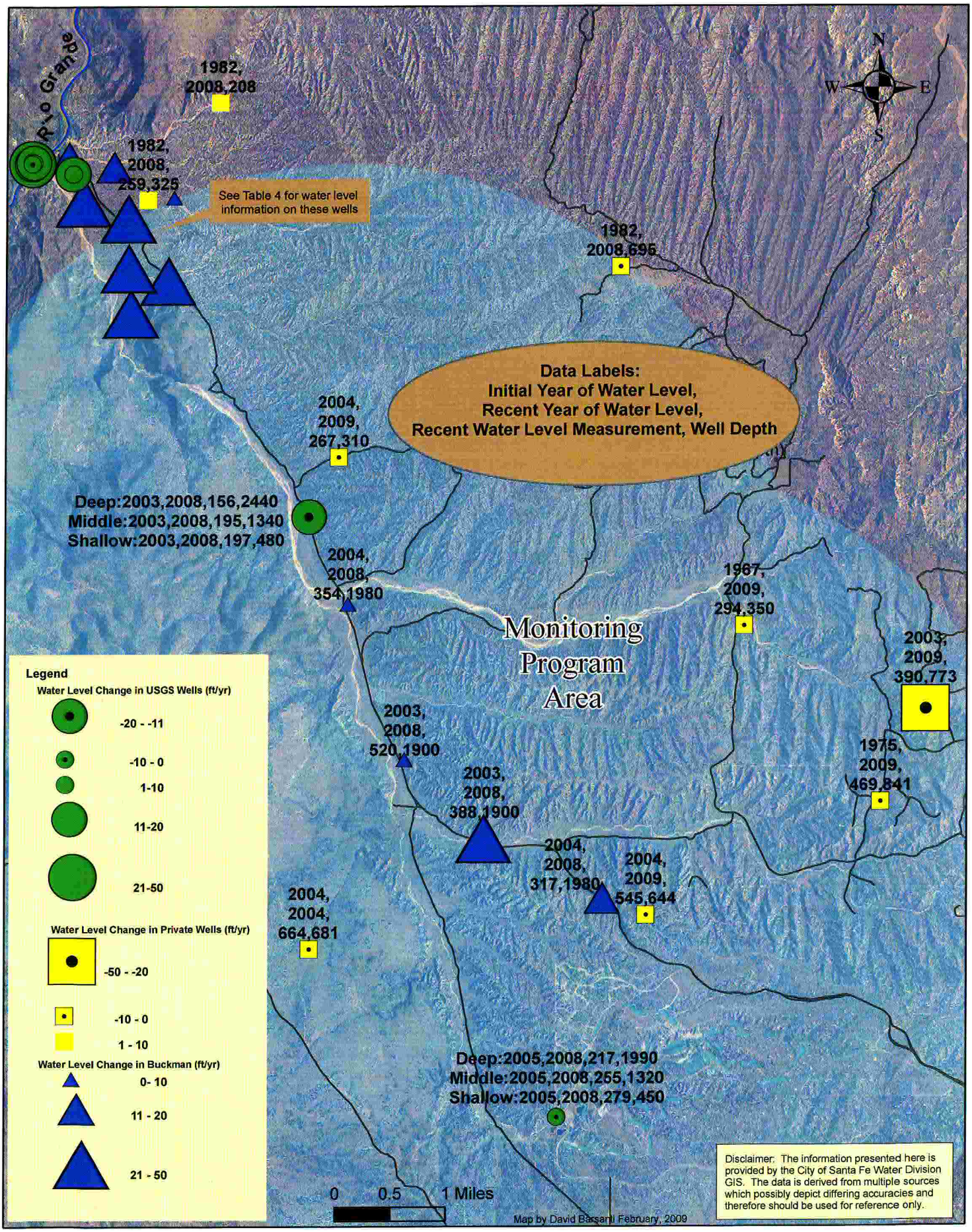

Figure 2: Water Level Changes in the Monitoring Program Area

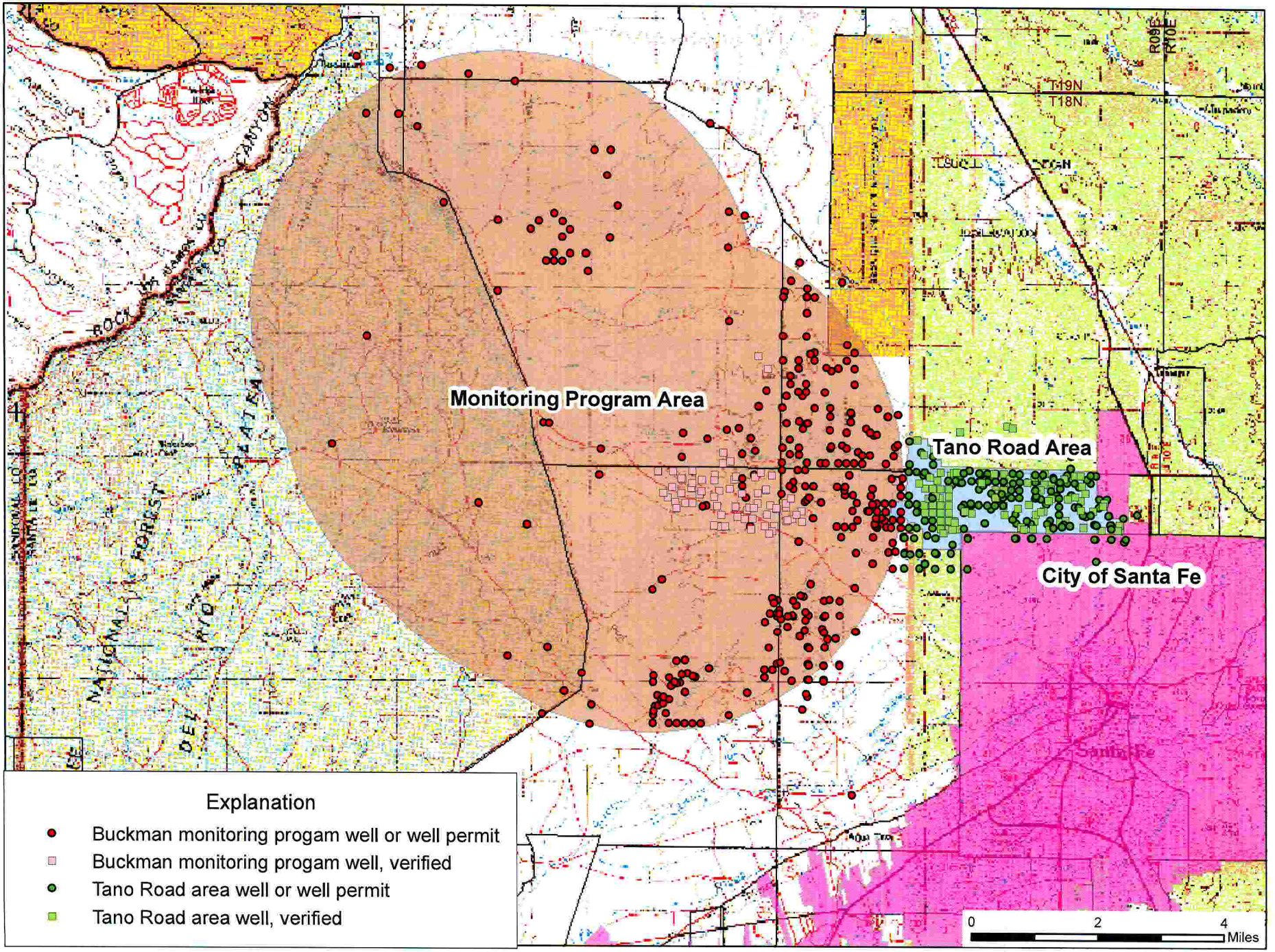

Figure 3. Wells in the Buckman Monitoring Program Survey Area.