#1944434
Project 2009

NORWEST
Applied Hydrology

July 31, 2008

Peter Gintautas
Environmental Protection Specialist
Colorado Oil and Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, CO 80203

Subject: Status Report, North Fork Ranch Groundwater Monitoring, Raton Basin, Colorado

Dear Mr. Gintautas:

Please find attached a status update of groundwater monitoring activities in the North Fork Ranch area of the Raton Basin, conducted by Norwest Applied Hydrology on behalf of Pioneer Natural Resources. This report was prepared, at your request, to update you on monitoring activities and data since the last update report on February 15th, 2008. Water level and water quality data collected through July 7th, 2008 are included in this report.

Please contact me if you have any comments or questions regarding the report.

Sincerely,
Norwest Applied Hydrology

Martin Johnson

Martin S. Johnson, P.G.
Senior Hydrogeologist

Attachments

cc. Gerald Jacob, Pioneer Natural Resources USA

STATUS REPORT
North Fork Ranch Groundwater Monitoring
July 31, 2008

Summary:

Four groundwater monitoring wells were installed in the North Fork Ranch subdivision of the Raton Basin (Figure 1) in September and November, 2006 to monitor groundwater conditions in the subdivision. The four monitoring wells were equipped with transducers and dataloggers to measure and record water level and water temperature changes. Two of the wells also monitor electrical conductivity. The purpose of the wells is to monitor background groundwater conditions and provide data on any changes in groundwater quality that occur as a result of coalbed methane (CBM) development in the area. The transducer data are supplemented by water samples collected periodically from each of the four wells and submitted for laboratory analysis, as described in the workplan for Groundwater Monitoring, North Fork Ranch Subdivision dated October 11, 2006.

This report summarizes groundwater monitoring activities and data obtained since January 1, 2008. Previous monitoring activities and data were documented in a status report dated February 15, 2008.

Water level data:

Water level measurements made in the four monitoring wells since installation are summarized in Table 1. Levels were measured with an electric sounding tape each time the wells were sampled or data were downloaded from the transducers. The Dolores monitoring well had fewer measurements because the well, originally drilled to be used for water supply, could not be easily accessed. The Niagara monitoring well did not contain water when completed or when measured after 6 months; however, it contained sufficient water to measure beginning in September, 2007. Manual water-level measurements were used to check and verify the pressure transducer data presented below.

Sanchinator MW:

Water-level data recorded by the pressure transducer in the Sanchinator well are shown on Figure 2. Also shown on the figure are data recorded since October, 2007, which includes the period when the Sanchinator 11-36 TR well was drilled. The chart shows a fairly constant water level from January 1, 2007 until purging for monthly well samples began in late March. A pattern of steep declines followed by more gradual recovery then followed each month through June 30th. The electrical conductivity measured and recorded by the transducer, also shown on Figure 2, rose gradually from January 1st to June 30th, 2008. The water level and conductivity data do not show any changes during the period that can be attributed to CBM activities.

Keystone MW:

Water level data and water temperature measurements from January 30th to July 7th, 2008 are shown on Figure 3. The chart shows that the water level and water temperature did not vary significantly over the period of record.

Niagara MW:

As Table 1 shows the Niagara MW has had measurable water since September, 2007 and had a steadily rising water level until March 25, 2008. The transducer record (Figure 4) indicates a rising water level from March through June 12, 2008. A replacement for the Niagara 23-35 CBM well was drilled in late May, 2008. The water level and temperature records do not show any changes coinciding with the well drilling activities. The transducer data and analytical results discussed below indicate that the source of water in the Niagara well is bedrock groundwater and not infiltration from surface pits.

Dolores MW:

The transducer data for the Dolores monitoring well are shown on Figure 5 for the period of February 1 to July 7, 2008. As in the past, the water level record shows a pattern of regular fluctuations on an approximately weekly interval, probably reflecting hydraulic connection between the monitoring well and the Dolores domestic well, located 300 feet to the south. The short-term fluctuations are relatively small (<1 ft) and do not seem to affect the long-term trend, which is constant at a depth of about 67 feet. Water temperature data are very consistent with only minor fluctuations.

Water Quality:

The Keystone, Niagara, and Dolores monitoring wells were sampled in March and June/July, 2008, and the samples submitted for laboratory analysis. Results of the analyses are shown on attached Table 2 along with previous data from the Keystone, Dolores, and Sanchinator wells. The Niagara well had not been sampled previously because the well did not contain sufficient water to sample before January 2008. The Sanchinator well was sampled monthly from March 25th to June 26th, 2008 to confirm that the groundwater chemistry at the well had stabilized after laboratory results from previous samples varied greatly in some constituent concentrations.

The analytical results for the Keystone and Dolores wells were generally consistent with previous sample results from 2006 and 2007. Variability in analyte concentrations for the period are generally less than +/- 15% and there are no trends that would suggest external influences. Likewise the laboratory results for monthly samples from the Sanchinator well were consistent from month to month and with samples collected in September, 2007. These data indicate that the first samples collected from the Sanchinator well in November, 2006 were not representative of the groundwater monitored by the well and likely were diluted by the water used during drilling.

The samples collected from the Niagara well were chemically similar to each other but had higher concentrations of some constituents than the other monitoring wells, including bicarbonate alkalinity, chloride, sodium, and TDS. The differences in major ion concentrations are illustrated by Stiff Diagrams in Figure 6. The concentrations of these constituents were much lower than would be expected from pit infiltration or produced water; however, and apparently reflect the bedrock groundwater quality of the formations tapped by the monitoring well. Figure 7 shows the Stiff Diagram for the Niagara well compared to plots from some typical produced water pit samples from the Raton Basin.

The monitoring well samples were not filtered in the field and so, could not be directly compared with Colorado Water Quality Control Commission Human Health Standards for most analytes. However, selected metals and TDS were filtered in the lab from unpreserved samples and could therefore be compared CWQCC Standards. Dissolved manganese and TDS exceeded Drinking Water Standards in samples from the Sanchinator and Niagara wells. Dissolved manganese and pH exceeded drinking water standards in some of the samples from the Keystone and Dolores wells. Also, although not directly comparable to CWQCC Standards, total fluoride concentrations exceeded Human Health Standards in all samples and total iron exceeded Drinking Water Standards in all samples.

Plans:

Transducers are continuing to record data at 15-minute intervals in all four monitoring wells and will be checked, downloaded, and recalibrated whenever the wells are sampled. The wells will be sampled on a quarterly frequency or more often if needed to monitor nearby CBM activity. The Sanchinator well will be sampled at the end of July, 2008, providing five consecutive months of samples and, unless there is an unexpected change in water quality, will be returned to a quarterly sampling schedule thereafter. The next update report, summarizing data collected from July 1st, 2008 to January 31st, 2008 will be prepared by January 31st, 2009.

Table 1
Water-level Data
Northfork Ranch Monitoring Wells

Well	Surface elevation (ft)	Date measured	Depth to water (ft)	Water level elevation (ft)
Dolores MW	**7920**	4/18/2007	63.41	7856.59
		5/16/2007	64.90	7855.10
		9/6/2007	64.90	7855.10
		2/1/2008	67.70	7852.30
		3/25/2008	66.34	7853.66
		7/7/2008	67.46	7852.54
Keystone MW	**7957.71**	11/20/2006	28.30	7929.41
		12/1/2006	28.71	7929.00
		12/11/2006	29.45	7928.26
		3/1/2007	30.24	7927.47
		3/21/2007	29.50	7928.21
		9/6/2007	31.50	7926.21
		2/1/2008	33.93	7923.78
		3/25/2008	33.14	7924.57
		7/7/2008	33.43	7924.28
Niagara MW	**8087.04**	12/1/2006	ND	ND
		5/16/2007	ND	ND
		9/6/2007	245.60	7841.44
		1/30/2008	231.49	7855.55
		3/25/2008	226.60	7860.44
		5/29/2008	227.40	7859.64
		6/25/2008	225.20	7861.84
Sanchinator MW	**8384.29**	12/4/2006	488.33	7895.96
		12/5/2006	490.35	7893.94
		12/12/2006	500.73	7883.56
		3/21/2007	517.16	7867.13
		4/30/2007	519.60	7864.69
		5/10/2007	532.40	7851.89
		5/16/2007	526.68	7857.61
		9/5/2007	519.12	7865.17
		10/3/2007	523.20	7861.09
		1/30/2008	517.75	7866.54
		4/29/2008	521.30	7862.99
		5/29/2008	523.10	7861.19

TABLE 2
North Fork Ranch Monitoring Well Data

Constituent	Method	Reporting Limit	Units	Human Health Std.*	Drinking Water Std.**	Organic Chemical Std.***	Sanchinator MW 11/18/2006	Sanchinator MW 9/5/2007	Sanchinator MW 3/24/2008	Sanchinator MW 4/29/2008	Sanchinator MW 5/29/2008	Sanchinator MW 6/26/2008	Keystone MW 11/20/2006	Keystone MW 9/6/2007	Keystone MW 3/25/2008	Keystone MW 7/7/2008	Dolores MW 9/26/2006	Dolores MW 9/5/2007	Dolores MW 3/25/2008	Dolores MW 7/7/2008	Niagara MW 3/25/08	Niagara MW 6/27/08
Alkalinity	310.1	5.0	mg/L				170	190	196	208	203	223	134	155	159	169	163	160	165	173	443	414
Arsenic - T.Rec	200.8	0.0025	mg/L				0.0081	0.0042	0.0055	0.0039		0.0030	0.0025	ND	ND	ND	0.0026	ND	ND	ND	0.004	
Barium - T.Rec	200.8	0.0050	mg/L				0.170	0.1300	0.1200	0.1100		0.084	0.210	0.11	0.049	0.041	0.022	0.051	0.038	0.041	0.280	
Benzene	8021B / 524.2	0.0005	mg/L			0.005	ND	ND	ND	0.0025	0.00066	ND	0.00093	0.0021	0.0016	0.0013	ND	ND	ND	ND	0.0015	0.0019
Bicarbonate Alkalinity	310.1	5.0	mg/L				170	190	195	208	201	223	134	148	158	169	138	143	156	171	443	414
Boron - T.Rec	200.8	0.100	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Boron - Total	6010B	0.050	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromide	300.0	0.20	mg/L				ND	0.52	ND	0.65	0.64	0.62	ND	ND	ND	ND	ND	ND	ND	ND	0.69	0.64
Cadmium - Total	200.7	0.0050	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium - Total	200.7	0.20	mg/L				3.1	33.70	17.00	8.30	7.6	15.4	36.5	6.8	4.7	4.4	2.3	2.8	2.4	3.9	14.2	13.8
Calcium - Total	6010B	0.200	mg/L				3.1	33.9	17.0	8.2	7.0	15.1	32.3	7.1	5.1	4.7	9.5	2.8	2.6	3.9	15	12.8
Carbonate Alkalinity	310.1	5.0	mg/L				32.1	ND	ND	ND	ND	ND	ND	7.2	ND	ND	25.1	17.8	9.8	ND	ND	ND
Chloride	300.0	1.0	mg/l				8.0	115	9.1	106	91.9	98.8	3.9	7.4	7.6	6.8	13.6	14.3	12.8	14.0	95.2	88.4
Chromium - Total	200.7	0.010	mg/L				0.012	0.25	0.027	ND	ND	0.017	ND	0.014	ND	ND	ND	0.011	ND	0.022	0.02	ND
Copper - Diss.	200.7	0.010	mg/L		1		ND	0.023	0.067	ND	ND	ND	ND	ND	ND	ND	ND	0.023	ND	0.011	ND	ND
Copper - T.Rec	200.8	0.0050	mg/L				0.0082	0.021	0.120	0.009		0.008	ND	ND	ND	ND	0.011	0.023	ND	0.032	0.0091	
Ethane	RSK-175	0.0050	mg/L				ND	ND	ND	ND	ND	ND	0.017	0.032	0.053	0.054	ND	ND	ND	ND	0.18	ND
Ethene	RSK-175	0.0050	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	8021B / 524.2	0.0005	mg/L			0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoride	300.0	0.20	mg/L				8.3	8.2	0.260	7.50	7.7	8.4	0.66	6.1	4.9	5.1	7.3	7.2	6.5	6.9	7.6	8.9
Hydroxide Alkalinity	310.1	5.0	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron - T.Rec	200.7	0.10	mg/L				12.7	0.71	1.1	0.38	0.6	1.1	2.20	11.1	1.8	1.2	0.066	2.0	0.51	4.8	1.9	1.3
Iron - Total	6010B	0.10	mg/L				12.5	0.92	0.99	0.40	0.49	1.1	2.10	10.6	1.8	1.2	16.2	1.9	0.49	4.4	1.8	1.2
Lead - T.Rec	200.8	0.0015	mg/L				0.0036	0.0017	0.014	0.0018		0.0049	ND	0.0025	ND	ND	0.0086	0.0027	0.0015	0.0052	0.004	
Magnesium - T.Rec	200.7	0.20	mg/L				1.30	0.81	0.69	0.51	0.46	0.88	4.90	2.5	0.79	0.55	0.29	0.47	ND	0.68	0.65	0.56
Magnesium - Total	6010B	0.20	mg/L				1.30	0.85	0.63	0.54	0.42	0.86	4.40	2.4	0.79	0.57	3.6	0.47	0.15	0.57	0.63	0.53
Manganese - Diss.	200.7	0.010	mg/L		0.05		0.12	0.011	0.085	0.066	0.086	0.072	0.260	0.20	0.06	0.049	0.12	0.011	0.016	0.063	0.23	0.18
Manganese - T. Rec	200.7	0.010	mg/L				0.18	0.012	0.048	0.066	0.059	0.077	0.270	0.24	0.063	0.055	0.24	0.039	0.016	0.074	0.24	0.19
Methane	RSK-175	0.0050	mg/L				1.40	0.92	1.80	3.10	4.40	5.20	0.460	3.10	4.00	3.70	1.4	2.8	6.3	0.96	4.2	0.02
Nitrate	300.0	0.10	mg/L				ND	0.22	0.17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil & Grease	1664A HEM	5.0	mg/L				ND	ND	ND	ND	ND	6.9	ND	6.8	ND	ND	ND	ND	ND	ND	ND	ND
pH	150.1	0.10	-		6.5-8.5		9.2	8.2	8.2	8.2	8.3	8	7.8	8.8	8.7	8.5	9.1	9.2	9.0	8.9	7.8	8.4
Potassium - T.Rec	200.8	0.250	mg/L				1.90	1.20	1.300	0.880		0.890	2.50	1.3	0.75	0.5	1.9	0.49	0.41	1.10	1.9	
Potassium - Total	6010B	3.00	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	ND	ND	ND	ND	ND
Resistivity	120.1	0.00020	ohm-m				26.0	12.6	12.9	12	12.6	12.2	21.3	20.7	20.8	20	22.7	24.6	7.0	22.8	9.1	8.5
Selenium - T.Rec	200.8	0.0025	mg/L				ND	ND	ND	ND		ND	ND	ND	ND	ND	0.004	ND	ND	ND	ND	
Silver - Total	200.7	0.010	mg/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium - Total	200.7	5.0	mg/L				95.6	141	152	179	181	173	57.1	113	112	119	95.4	102	98.7	105	257	259
Sodium - Total	6010B	5.0	mg/L				89.7	151	153	199	169	171	49.6	122	117	123	105	104	104	109	264	238
Specific Gravity	D1429	0.00010	-				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1	1.00	1.00	1.00	1	1.00	1.00
Sulfate	300.0	5.0	mg/l		250		ND	9.3	41.7	33.2	22.6	24.6	85.8	67.9	69.1	64.2	24.7	11.9	15.7	21.2	7.1	8.2
Sulfide	376.2	0.050	mg/L				ND	ND	ND	ND	0.060	ND	ND	ND	0.067	ND	ND	ND	0.24	0.12	0.12	0.32
TDS	160.1	10.0	mg/L		400****		245	463	435	480	425	485	308	382	322	322	265	248	234	262	664	653
TEPH - DRO	8015B	0.250	mg/L				ND	ND	0.27	0.82	ND	0.63	ND	ND		0.96	ND	ND		ND		ND
Toluene	8021B / 524.2	0.0005	mg/L				ND	0.57	0.140	0.110	0.036	0.022	ND	ND	0.0011	0.00057	0.11	0.00061	0.0020	ND	ND	ND
TSS	160.2	4.0	mg/L				141	86.0	7.2	ND	11.2	27.6	32	ND	10.8	8.4	644	104	14.4	55.2	27.6	21.2
Xylenes	8021B / 524.2	0.0005	mg/L				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc - Diss.	200.7	0.020	mg/L		5		0.023	0.044	0.087	0.020	0.071	0.034	ND	0.033	0.02	ND	0.029	0.044	ND	0.037	0.054	0.025
Zinc - Total	200.7	0.020	mg/L				0.020	0.035	0.037	ND	ND	0.030	ND	0.029	ND	ND	0.056	ND	ND	0.026	0.052	0.02

Data reported in mg/L except as noted
The Reporting Limit may be adjusted due to high concentrations of the target constituent.
ND = Not Detected at requested reporting limit

* Domestic Water Supply - Human Health Standards from Table 1, Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41. Equivalent to Maximum Contaminant Levels for Public Water Supplies from National Primary Drinking Water Standards, 40 CFR Part 141
** Domestic Water Supply - Drinking Water Standards from Table 2, Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41. Equivalent to Secondary Maximum Contaminant Levels for Public Water Supplies from National Secondary Drinking Water Standards, 40 CFR Part 143
*** Organic Chemical Standard - Interim Organic Pollutant Standards from Table A, Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41
**** TDS Water Quality Standards from Table 4, Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41

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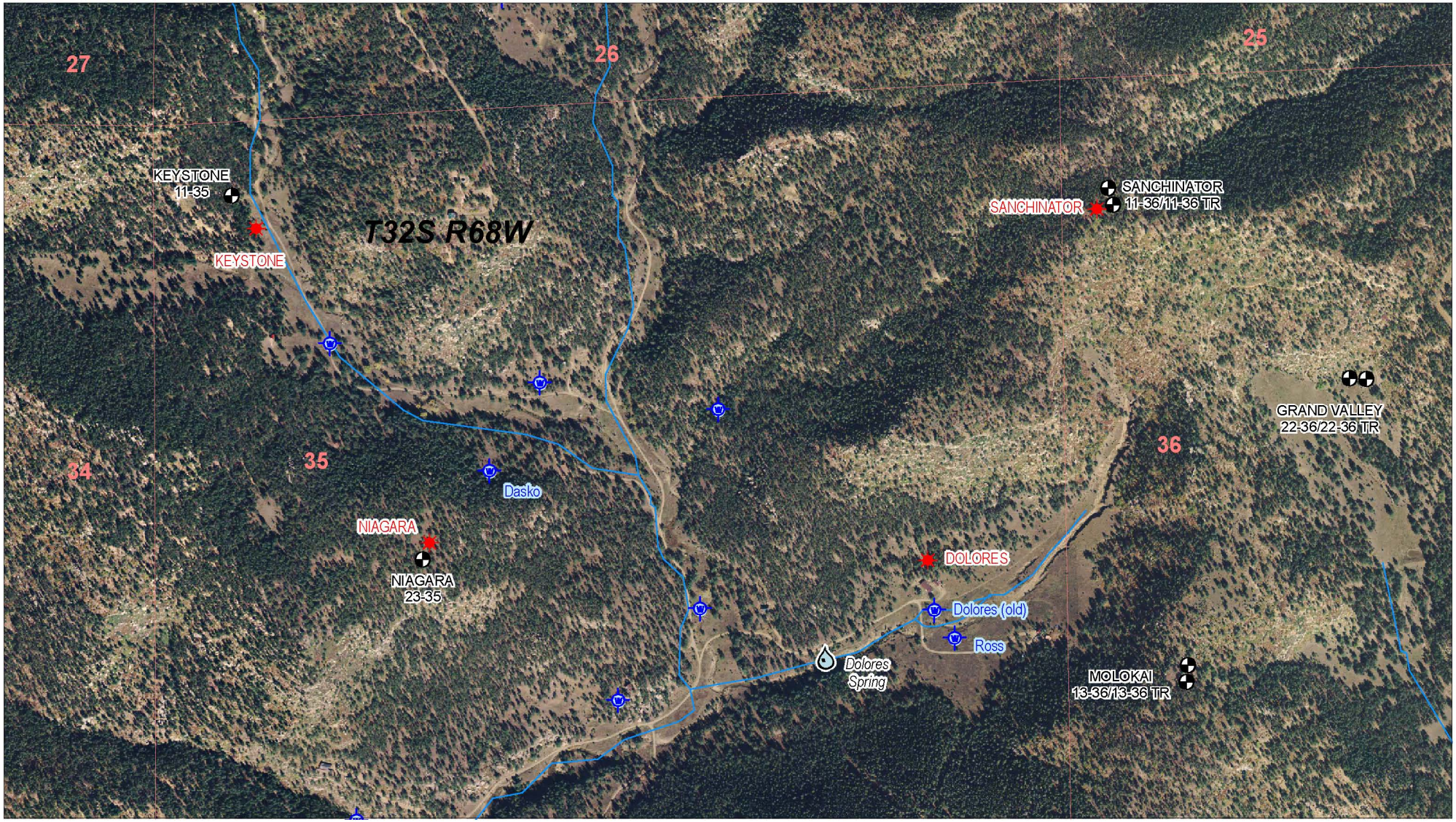
Figure 1
Site Location Map



Legend

- Monitoring Well
- Water Well
- Spring
- CBM Well
- Stream
- Section Line

1:10,000

N
W E
S

0 250 500 1,000 1,500 2,000

Feet

Projection: UTM
Datum: NAD 1927
Zone: 13N
Units: Feet

Created: MD
Date 3/27/2007

PIONEER
NATURAL RESOURCES

Figure 2
Sanchinator MW Transducer Data
10/3/2007 to 6/26/2008

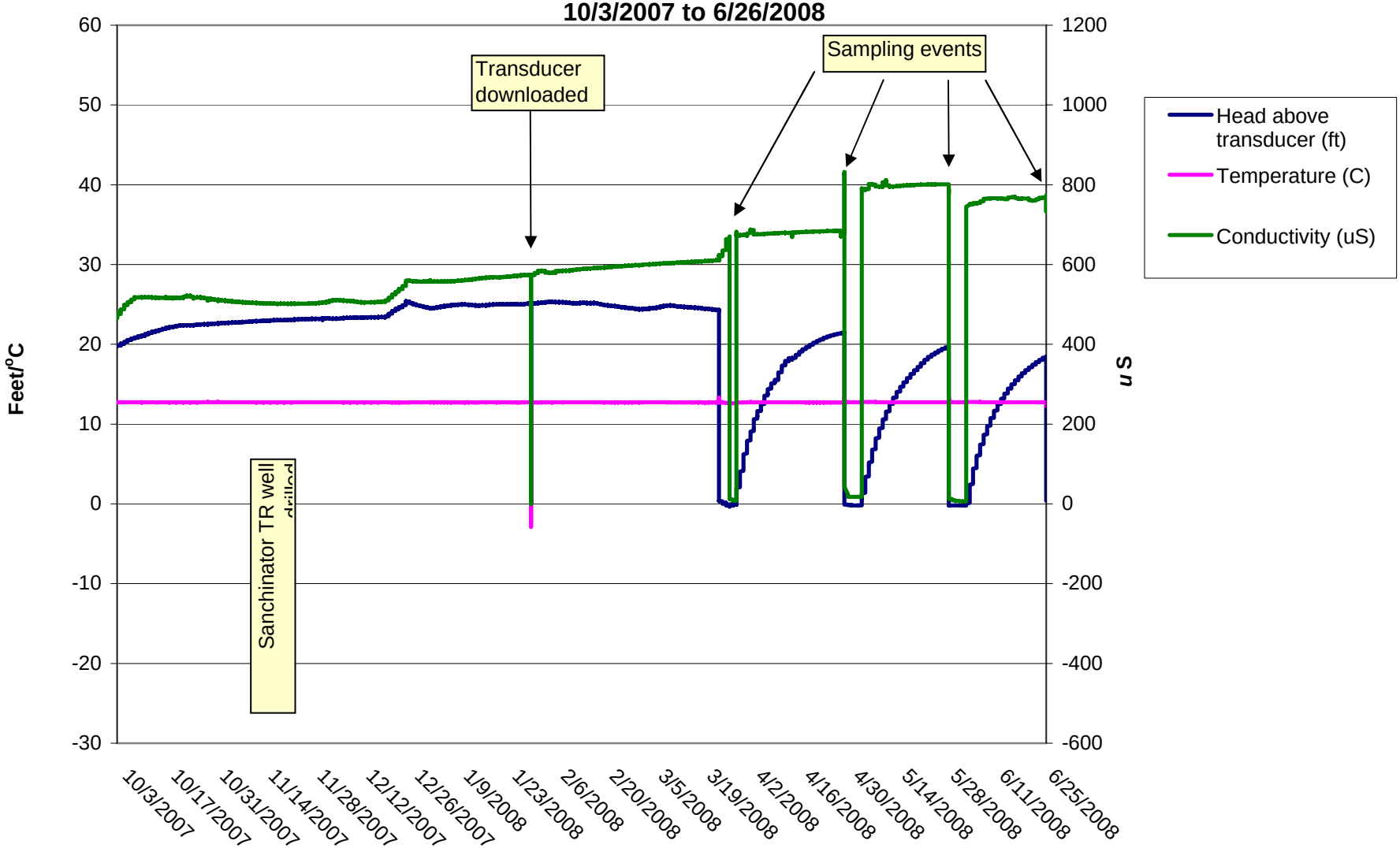


Figure 3
Keystone MW Transducer Data
2/1/2008 to 7/7/2008

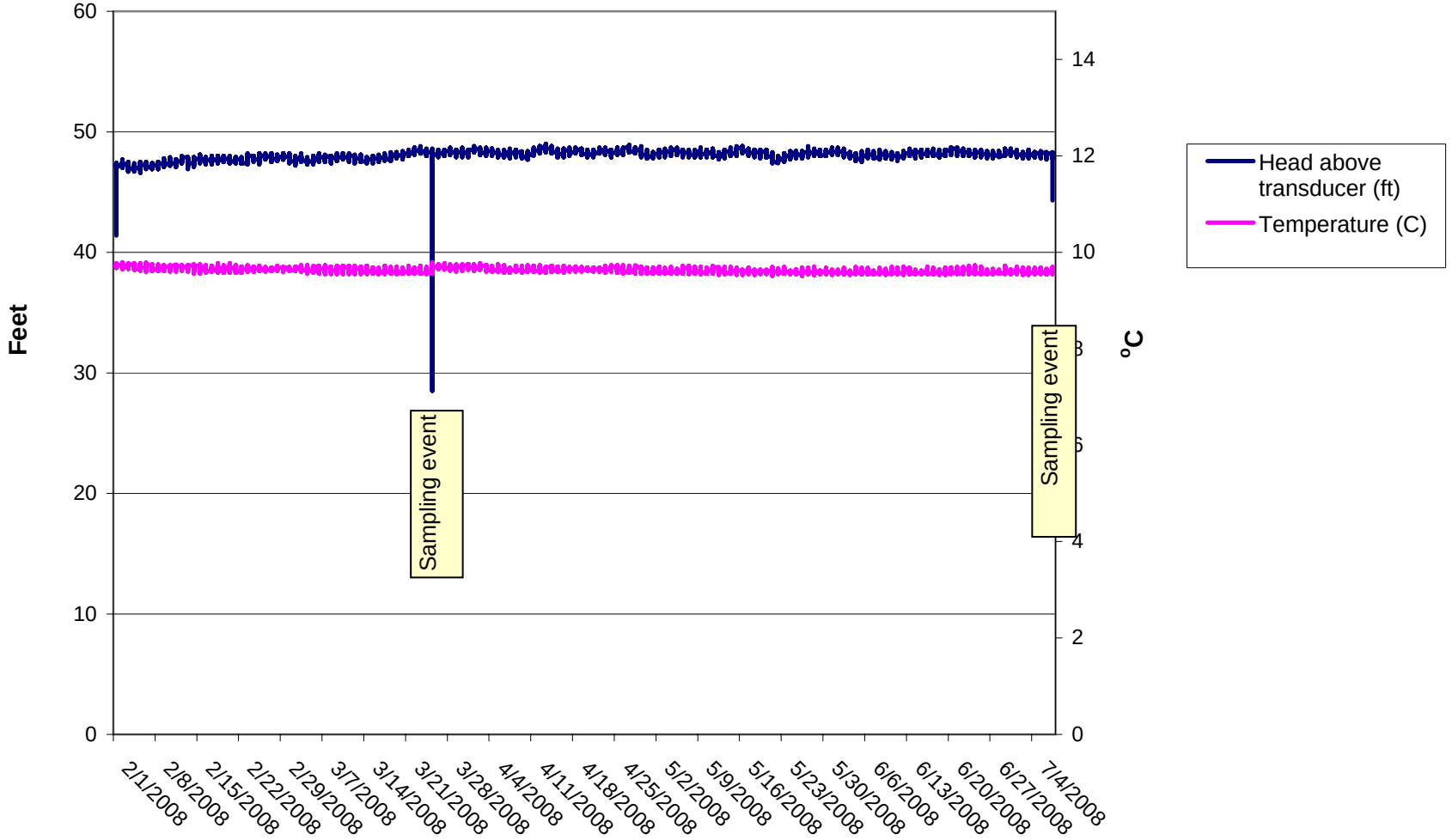
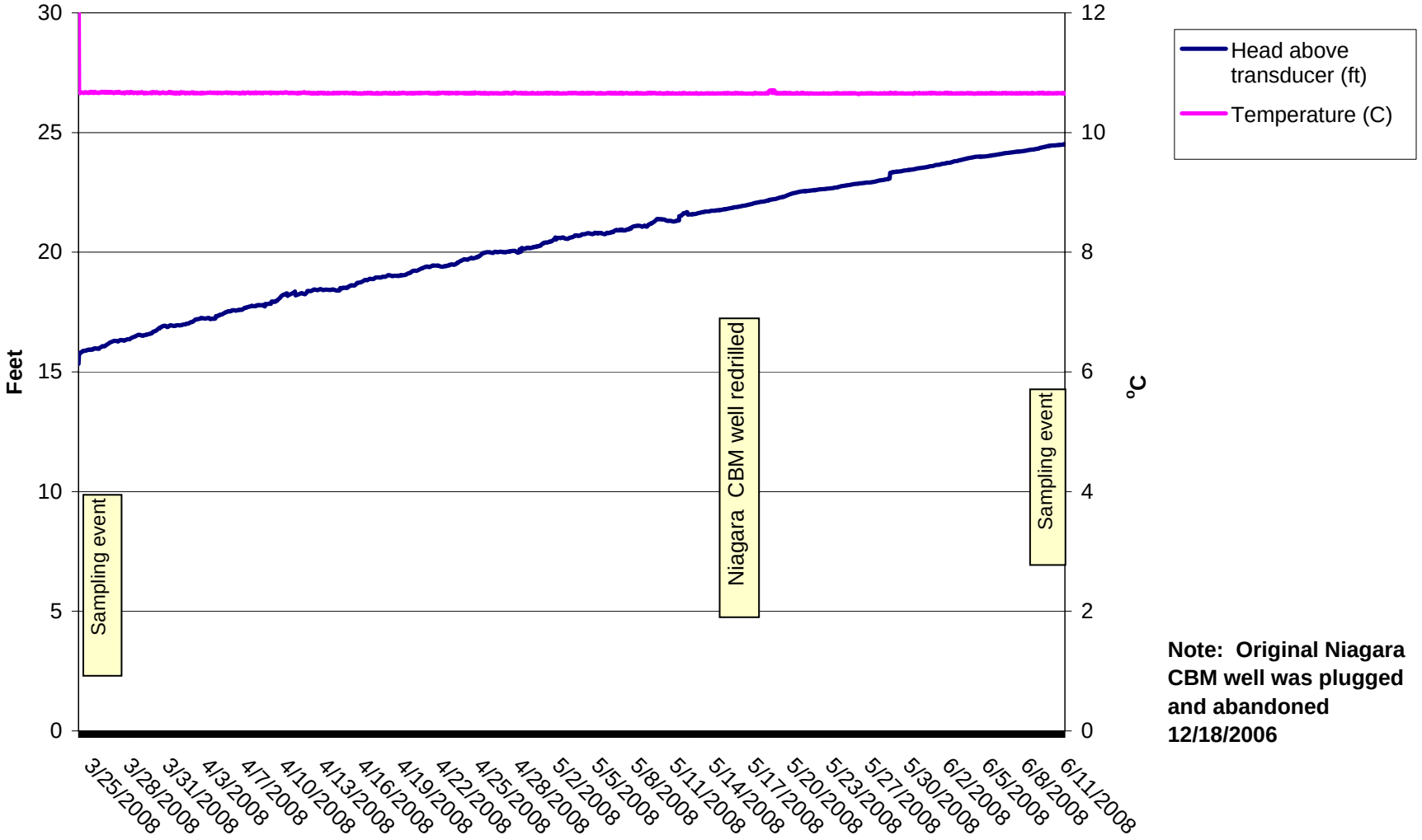
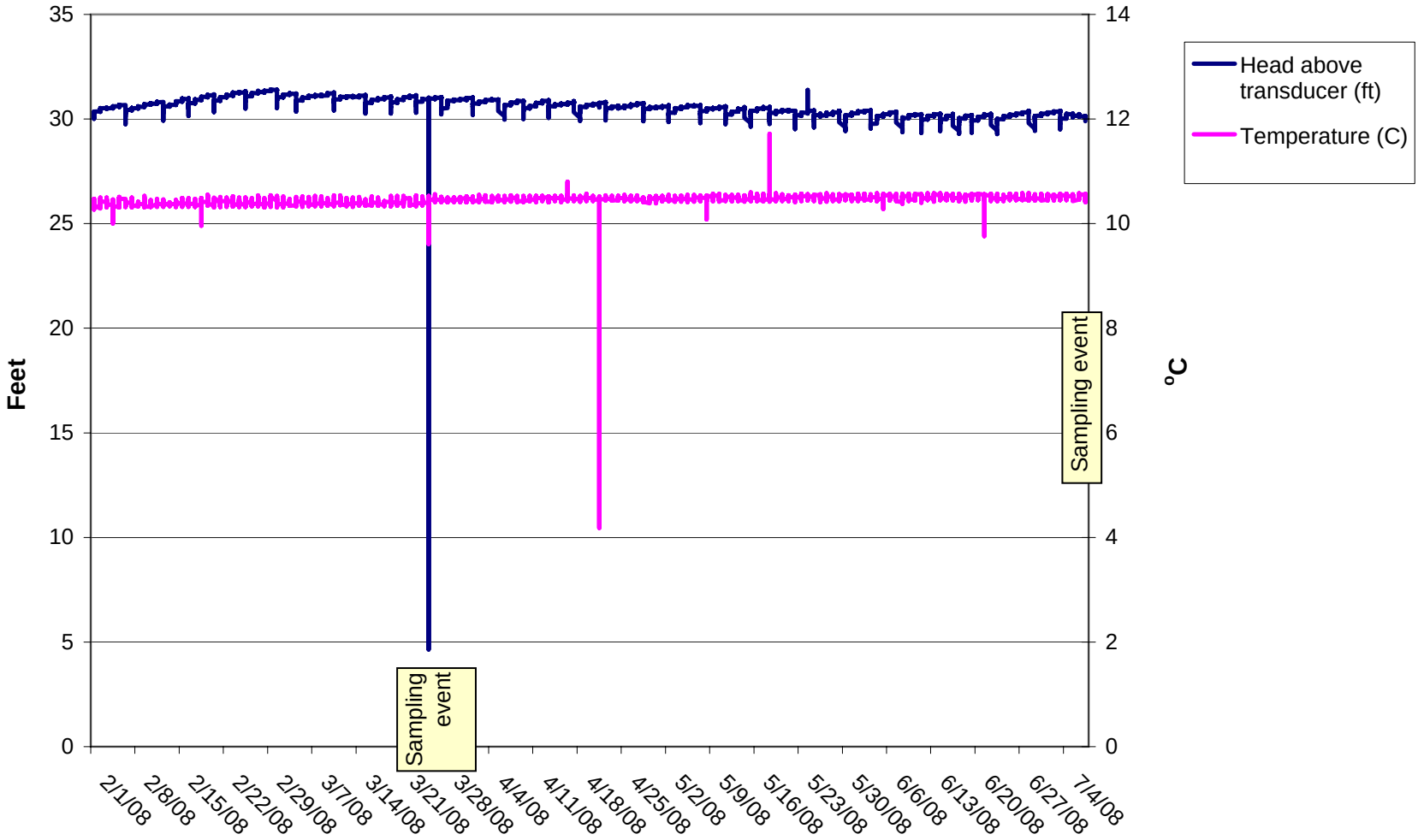


Figure 4
Niagara MW Transducer Data
3/25/08 to 6/12/08



Note: Original Niagara CBM well was plugged and abandoned 12/18/2006

Figure 5
Dolores MW Transducer Data
2/1/2008 to 7/7/2008



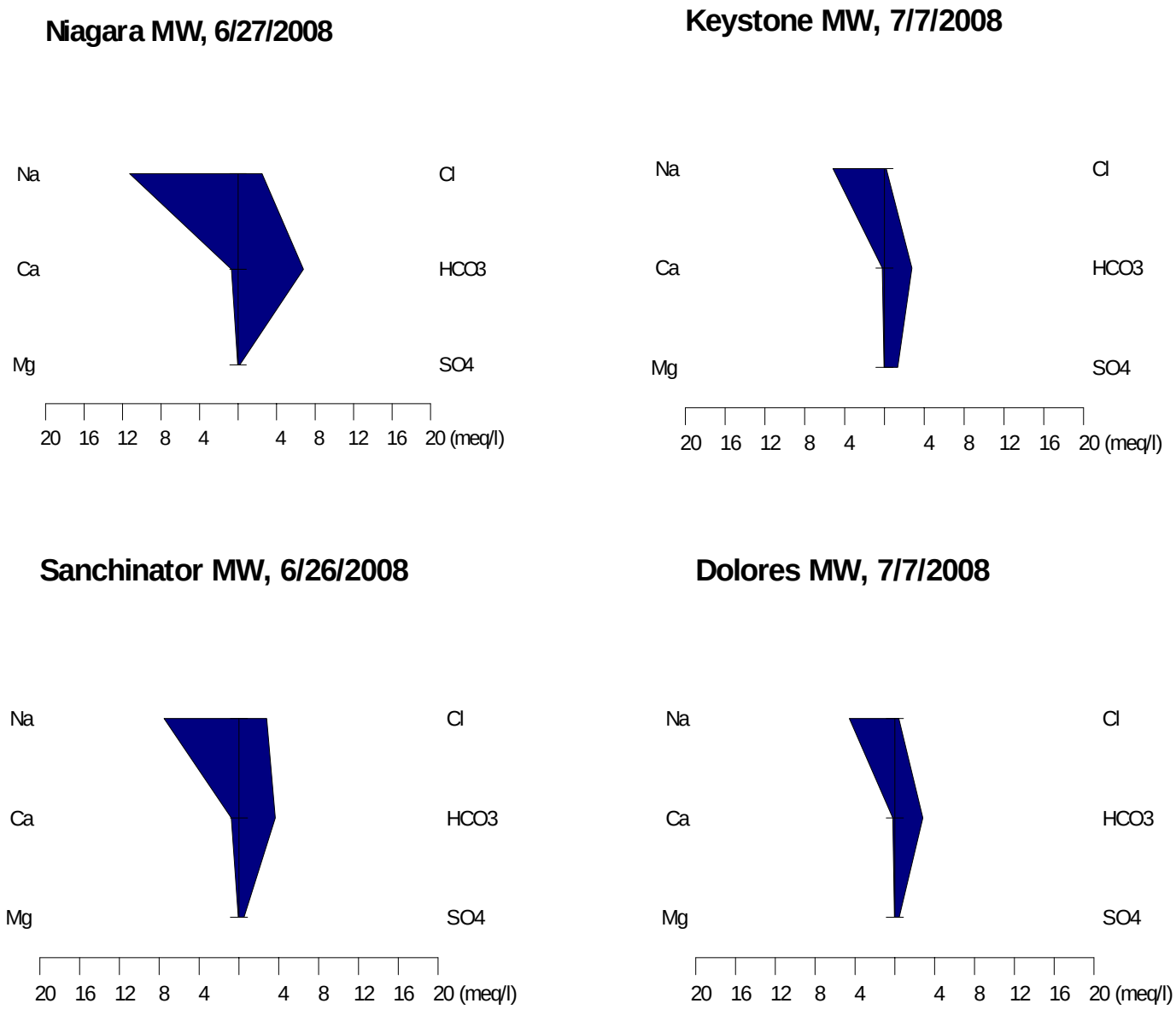


Figure 6. Stiff diagrams of major ions, North Fork Ranch monitoring wells

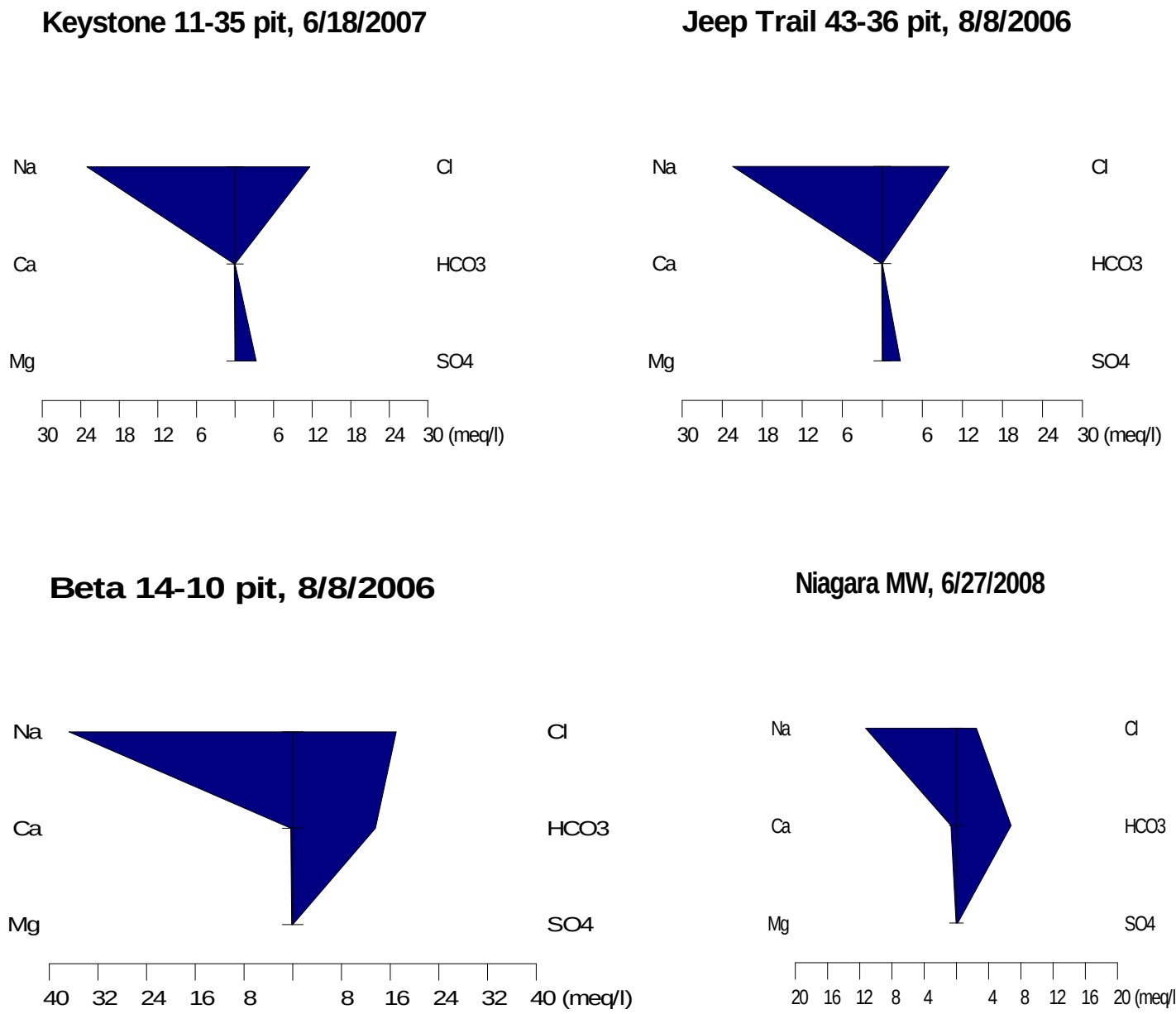


Figure 7. Stiff diagrams of major ions from production pit and Niagara well samples