2.7 HYDROLOGY

NUREG 1569 Section 2.7 states: "Characterization of the hydrology at in situ leach uranium extraction facilities must be sufficient to establish the potential effects of in situ operations on the adjacent surface water and groundwater resources and the potential effects of surface water flooding on the in situ leach facility" (US Nuclear Regulatory Commission). To meet these requirements, this section addresses surface water features (Section 2.7.1), groundwater characteristics (Section 2.7.2), surface water and groundwater quality (Section 2.7.3).

2.7.1 Surface Water

2.7.1.1 Drainage Basins

Delineation of drainage basins on the Moore Ranch Project area was previously conducted and presented to the NRC in the Environmental Report for the Sand Rock Mill Project, Docket No. 40-8743 (1980) and subsequent Draft Environmental Statement prepared by the NRC (1982). Those documents were referenced to provide the following drainage basin descriptions.

The project area lies entirely within the drainage basin of Ninemile Creek, which is a tributary to Antelope Creek. Antelope Creek flows into the South Cheyenne River (Wyoming nomenclature) which joins the Belle Fourche River in South Dakota to form the Cheyenne River. The Cheyenne River subsequently flows into the Missouri River. The entire Antelope Creek drainage basin is shown on Figure 2.2-4 and discussed in Section 2.2. Ninemile Creek tributaries which are relevant to the project are shown on Figure 2.7.1-1.

Antelope Creek has a drainage area of 980 square miles with an approximate channel length of 62 miles and an average gradient of 0.006 (ft/ft). The elevation at Antelope Creek's headwaters is approximately 6,225 feet above mean sea level (msl), and 4,400 feet at its confluence with the South Cheyenne River. The U.S. Geological Survey has a stream gaging station on Antelope Creek approximately ten miles upstream from its mouth. The drainage area is 959 square miles, at the gage.

Ninemile Creek has a total drainage area of 63 square miles, a channel length of approximately 20 miles, and an average channel gradient of 0.006 (ft/ft). The elevation difference from headwaters to mouth is 610 feet with a maximum basin elevation of approximately 5,500 feet above msl. The channel length within this area is approximately 10.5 miles with an average gradient of 0.007 (ft/ft).

Simmons Draw is a Ninemile Creek tributary flowing southeasterly through the project (Figure 2.7.1-1). Its total drainage area is 8.1 square miles. The channel length is 6.8 miles with an average gradient of 0.007 (ft/ft). Total basin elevation difference is 260 feet with a maximum elevation of approximately 5,475 feet above msl.

Pine Tree Draw, with a drainage area of 8.2 square miles, flows from the north into Ninemile Creek on the eastern edge of the project area (Figure 2.7.1-1). The channel length is approximately 7.6 miles, and the average gradient is 0.009 (ft/ft). The maximum basin elevation approaches 5,470 feet above msl, and the minimum is approximately 5,110 feet.

Simmons Draw has two tributaries which flow in a predominantly southerly direction in the project area. These tributaries are labeled Washes Nos. 1 and 2 on Figure 2.7.1-1. Wash No. 2 is further subdivided into Upper Wash No. 2 and Lower Wash No. 2 based on the channel reach being upstream and downstream of the proposed mining Wellfield 2. Wash No. 4, which is tributary to Ninemile Creek, is also further divided into Upper Wash No. 4 and Lower Wash No. 4 at the location of the proposed mill tailings evaporation pond dam.

Wash No. 1 has a drainage area of 1.7 square miles, a channel length of 2.8 miles, and an average channel gradient of 0.014 (ft/ft). The basin elevation difference is approximately 205 feet with a maximum elevation of 5,475 feet above msl.

Upper Wash No. 2 and Lower Wash No. 2 have drainage areas of 1.9 and 0.95 square miles, respectively. Their respective channel lengths are 3.1 and 2.2 miles with average gradients of 0.012 and 0.007 (ft/ft).

The drainage areas of Upper Wash No. 4 and Lower Wash No. 4 are 0.70 and 0.53 square miles respectively. Channel lengths are 0.46 and 1.3 miles with respective gradients of 0.017 and 0.013 (ft/ft).

Wash No. 3 (Figure 2.7.1-1) drains into Pine Tree Draw from the northwest in Section 36 of T42N-R75W. Its drainage area is 1.8 square miles, the channel length and average gradient are 3.2 miles and 0.014 (ft/ft), respectively, and the basin elevation difference is approximately 230 feet. The maximum basin elevation is approximately 5,480 feet above msl.

Drainage basin characteristics for Antelope Creek, Ninemile Creek, and all of the tributaries relevant to the Moore Ranch project area are summarized in Table 2.7.1-1.

Table 2.7.1-1 Drainage Basin Characteristics For The Moore Ranch Project Area

Drainage Basin	Drainage Area (mi^2)	Channel Length (mi)	Elevation Differences (ft)	Channel (ft/mi)	Gradient (ft/ft)
Antelope Creek (total)	980	62	1,825	29.4	0.006
Antelope Creek (at USGS gage)	959	52	1,775	34.1	0.006
Ninemile Creek (Total)	63	20	610	30.5	0.006
Ninemile Creek (@ 1-7)	34	10.5	390	37.1	0.007
Pine Tree Draw	8.2	7.6	370	48.9	0.0009
Simmons Draw	8.1	6.8	260	38.2	0.0007
Wash No. 1	1.7	2.8	205	73.2	0.014
Upper Wash No. 2	1.9	3.1	190	61.3	0.012
Lower Wash No. 2	0.95	2.2	80	36.4	0.007
Wash No. 3	1.8	3.2	230	71.9	0.014
Upper Wash No. 4	0.70	0.46	130	90.2	0.017
Lower Wash No. 4	0.53	1.3	90	69.2	0.013

2.7.1.2 Surface Water Runoff

Peak flood estimates for each of the drainage basins within and directly adjacent to the Moore Ranch Project area were previously calculated and presented to the NRC in the Environmental Report for the Sand Rock Mill Project, Docket No. 40-8743 (1980) and subsequent Draft Environmental Statement prepared by the NRC (1982). Those documents were referenced to provide the following runoff estimates. These estimates are considered valid.

In those reports, three techniques were utilized for estimating flood flows and volumes ephemeral basins for different recurrence intervals as described below.

- Lowham (1976) presented a basin characteristics technique whereby peak flow was related to drainage area with consideration of different regions in the state. Lowham's regression equations can be used for basins with drainage areas between 5 and 5,300 square miles. However, using a graphical approach, his technique can be used for basins slightly less than one square mile in area.

- For small basins (approximately 10 square miles and less) Craig and Rankl (1977) developed basin characteristics regression equations which utilize other basin parameters in addition to drainage area to compute peak flows and flood volumes (Craig and Rankl, "Analysis of Runoff from Small Drainages in Wyoming, US Geological Survey, Open-File Report 77-727, 1977).

- Also, for small basins, the U.S. Soil Conservation Service (SCS) has developed a technique to estimate peak flows and flood volumes. These techniques are published in their Engineering Field Manual (1969). The SCS technique utilizes peak rainfall values published by the U.S. Weather Bureau and then takes into consideration soil and vegetation characteristics and basin slope and drainage area to make the flood flow and volume estimates.

The technique presented in Lowham (1976) has since been superseded by Lowham, 1988, and subsequently by Miller, 2003. Therefore, the flood estimates calculated from the techniques in Lowham (1976) are not considered valid and are not presented in this report. The methods used in Craig and Rankl (1977) for analysis for small drainage basins in Wyoming (later published in Craig and Rankl, "Analysis of Runoff from Small Drainages in Wyoming, US Geological Survey, Water Supply Paper 2056, 1978) and the SCS method are considered valid techniques for estimating runoff as described in WDEQ-LQD Guideline 8.

Table 2.7.1-2 presents flood flow and volume estimates for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year events. For comparison purposes, values obtained by utilizing the two techniques described above are tabulated.

Values listed in Table 2.7.1-2 under the SCS method were obtained using curve number 75 and 24-hour duration precipitation values from Miller and others (1973). Table 2.7.1-3 shows precipitation for selected recurrence intervals for different duration periods.

Table 2.7.1-2 Peak Flood Discharge Estimates for 5-, 10-, 25-, 50-, and 100-Year Recurrence Intervals for Drainages within the Moore Ranch Project Boundary

Drainage	Drainage Area (mi^2)	Craig and Rank's Method (CFS)					SCS Method (CFS)				
		5-year	10-year	25-year	50-year	100-year	5-year	10-year	25-year	50-year	100-year
Ninemile Creek	63	4,700	6,900	9,800	14,000	18,000					
Pine Tree Draw	8.2	1,100	1,600	2,200	3,100	3,900					
Simmons Draw	8.1	1,400	2,000	2,600	3,600	4,500					
Wash No. 1	1.7	410	580	770	1,100	1,310	150	250	350	450	550
Upper Wash No. 2	1.9	480	670	890	1,200	1,500	160	260	370	480	580
Lower Wash No. 2	0.95	500	640	770	990	1,200	100	150	240	310	360
Wash No. 3	1.8	400	560	760	1,000	1,300	160	260	360	470	570
Upper Wash No. 4	0.7	260	360	460	610	740	85	140	190	250	300
Lower Wash No. 4	0.53	270	350	440	570	670	70	110	150	210	250

Reference: Conoco, Inc. 1980. Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming, Docket No. 40-8743. July, 1980.

More recent peak discharge evaluations for similar drainages in the Powder River Basin were conducted to evaluate the performance of reconstructed stream channel reclamation at coal mines (Western Water Consultants, 1995). Rainfall-runoff simulations were based on the SCS triangular hydrograph method to estimate flood discharges for 10 and 100-year events. Flood discharge values calculated for drainage areas in Campbell County of similar size are shown to be relatively similar to 100-year flood discharge values for drainages within the Moore Ranch project area using the SCS method. Table 2.7.1-4 shows a comparison of the Moore Ranch 100-year flood estimates and 100-year flood estimates from similar size drainage basins evaluated in the Western Water Consultants, 1995 report.

Table 2.7.1-3 Precipitation Values for Selected Recurrence Intervals and Durations in the Moore Ranch Project Area (Inches)

Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr	Duration
5-Min	.25	.35	.42	.52	.59	.66	.83	5-Min
10-Min	.38	.54	.65	.80	.92	1.03	1.29	10-Min
15-Min	.48	.69	.83	1.01	1.16	1.30	1.64	15-Min
30-Min	.67	.95	1.14	1.40	1.61	1.81	2.27	30-Min
1-Hour	.85	1.21	1.45	1.78	2.03	2.29	2.87	1-Hour
2-Hour	.95	1.33	1.59	1.94	2.22	2.49	3.12	2-Hour
3-Hour	1.03	1.44	1.71	2.09	2.38	2.67	3.33	3-Hour
6-Hour	1.25	1.71	2.01	2.44	2.77	3.10	3.86	6-Hour
12-Hour	1.47	2.00	2.35	2.84	3.22	3.60	4.47	12-Hour
24-Hour	1.70	2.29	2.69	3.24	3.67	4.10	5.09	24-Hour

Table 2.7.1-4 Comparison of Moore Ranch Project SCS Method 100-year Flood Estimates with Recent Flood Estimates for Similar Size Drainage Basins in Campbell County

Drainage	Area (Square Miles)	SCS Method 100-year Peak Discharge (cfs)	Drainage	Area (Square Miles)	SCS Method 100-year Peak Discharge (cfs)
Wash No. 1	1.7	550	Russel Draw (05B0)	1.8	590
Upper Wash No. 2	1.9	580	Russel Draw (05B0)	1.8	590
Lower Wash No. 2	0.95	360	HA Creek Tributary (47C0)	1.03	351
Wash No. 3	1.8	570	Russel Draw (05B0)	1.8	590
Upper Wash No. 4	0.70	300	Lone Tree Prong (12B0)	0.68	279
Lower Wash No. 4	0.53	250	School Creek (64B0)	0.49	260

2.7.1.3 Flooding Potential For Facility Areas

Figure 2.8.5-2 and 2.8.5-8 show surface water features within the Moore Ranch Project Area in relation to proposed facilities and wellfields. Figures 2.1-2 and 2.1-3 also show the facilities in relation to surrounding topography. The central processing area and wellfield are located well above any surface water features that would be inundated during flooding events, and also located in a manner that insignificant runon will occur from upgradient sources. Runoff in these areas will consist primarily of overland sheet flow. The central plant and facilities area will be graded and sloped to direct precipitation runoff away from building foundations in all directions to a storm water conveyance system. Potential runon will also be intercepted and directed around the central plant area. The stormwater conveyance system will be designed to pass the 50-year flood. Due to the location of Wellfield 1 and the central plant area related to the surrounding topography, impacts from flooding are expected to be minimal.The stream channel in Upper and Lower Wash No. 2 is located near the center portion of Wellfield 2. The previous hydrologic analysis conducted by Conoco determined representative channel cross sections for Upper and Lower Wash No. 2 and water crest heights for 100-year and 5-year floods (see Appendix B5 for previous hydrologic analysis conducted by Conoco. Channel cross sections for Upper Wash No. 2 in the vicinity of Wellfield 2 (approximately 650 feet upstream) show a channel inundation depth of approximately 2.9 feet at a velocity of 7.4 ft/second. As shown Figure 2.8.5-8, the channel widens somewhat through Wellfield 2, so the water depth and velocity in the channel during a 100-year flood through Wellfield 2 is anticipated to be less than 2.9 feet and 7.4 ft/second. However, due to the ephemeral nature of the drainages in the area, this channel typically contains no flow.

2.7.1.4 Surface Control Structures

Several small dams and ponds exist within and downstream of the project that provide a level of control and storage of surface water. During normal runoff conditions, these ponds will contain all upgradient runoff. Many of these water features may contain higher levels of water after spring runoff or after large precipitation events but are generally reduced to small, isolated pools or are completely dry by the end of the summer. Relatively small amounts of surface discharge from coal-bed methane operations may also maintain small pools of water in these ponds during dry summer months.

Installation of Wellfield 2 monitor, injection, and production wells in main ephemeral stream channels will be avoided if possible. If it is necessary to install a well within the high water marks of a ephemeral channel, then adequate structural wellhead protection will be installed to protect the wells during potential flood conditions. Wellhead protection could include concrete berms, or reinforced steel/concrete well covers, etc. Properly sized culverts will be used for secondary access roads crossing across small drainages. Efforts will be made to construct secondary access roads to avoid crossing major drainages. However, if crossing a major drainage is required, then adequately sized culverts will be utilized and embankments will be protected from erosion using adequate best management practices (rip rap, rock, etc.) in accordance with WDEQ-LQD Rules and Regulations, Chapter 3. Culverts across significant drainages will be designed to pass the 25-year peak runoff event using head available at the entrance. The minimum culvert size of 18" will be utilized to divert drainage from roads or for crossing small drains or swayles. Crossings for major drainages will be constructed at or near right angles.

2.7.1.5 Surface Water Impacts From CBM Discharges

Currently, three Wyoming Pollutant Discharge Elimination System (WYPDES) permits exist within or adjacent to the license area. The following Table 2.7.1-5 summarizes these permits.

Table 2.7.1-5 WYPDES Permits in or near the Moore Ranch Project

WYPDES Permit	Facility Name	Operator
WY0040436	East Pine Tree Unit	Devon Energy Production Company
WY0051217	Palm Tree Project	Bill Barrett Corporation (BBC)
WY0055131	BBC Pine Tree Area	Bill Barrett Corporation (BBC)

Outfalls permitted under the three WYPDES permits are presented on Figure 2.7.1-2.

Table 2.7.1-6 provides the WYPDES effluent limitations for Devon's East Pine Tree Unit CBM Facility (WY0040436), Bill Barrett Corporation's, (BBC) Palm Tree Project CBM Facility (WY0051217) and BBC Pine Tree Area Permit (WY0055131).

Table 2.7.1-6 WYPDES Effluent Limitations for Permits in or near the Moore Ranch Project

Devon – East Pine Tree Unit (Outfalls 001-002, 004-015, 017-030)[1]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	2.4
Total Recoverable Barium, µg/L	1800
Total Dissolved Solids, mg/L	5000
Total Flow[4], MGD	0.68
BBC – Palm Tree Project (Outfalls 001 - 025)[2]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	5.3
BBC – BBC Pine Tree Area (Outfalls 004 - 008)[3]	
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	1.02

[1] Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
[2] BBC's Palm Tree Project permit (WY0051217), effective February 4, 2008.
[3] BBC's BBC Pine Tree Area permit (WT0055131), effective October 4, 2007.
[4] Total flow is for all outfalls permitted under each permit number, in million gallons per day.

Table 2.7.1-7 provides a list of reservoirs permitted through the Wyoming State Engineers Office (WSEO) within the license area that may be impacted by CBNG produced water discharge. The reservoir locations are depicted on Figure 2.7.1-2

Table 2.7.1-7 WSEO Permitted Reservoirs with the Moore Ranch License Area

SEO Permit No.	Qtr-Qtr	Section	Township	Range
P16543S	NWSW	1	41N	75W
P14042S	NWNE	25	42N	75W
P14041S	SESW	25	42N	75W
P14040S	SWSE	25	42N	75W
P14043S	NWNE	26	42N	75W
P14036S	SWSW	26	42N	75W
P14037S	NESE	27	42N	75W
P14038S	SWSE	35	42N	75W
P14039S	NWSE	36	42N	75W

Tables 2.7.1-8 provides a list of the discharge points located within the license area. These discharge points are also presented on Figure 2.7.1-2 as are a number of others outside of the license area.

Table 2.7.1-8. CBM WYPDES Permits and Outfall Locations Within or Upstream of the Moore Ranch Project

Company	Permit #	Outfall #	Qtr-Qtr	Sec	Twp	Rng	Latitude	Longitude
Devon	WY0040436	001 EPTD	NWNE	25	T42N	R75W	43.59012	-105.81289
		002 EPTD	SENE	25	T42N	R75W	43.58458	-105.80856
		004 EPTD	SESE	25	T42N	R75W	43.5806	-105.8100
		005 EPTD	SWSE	25	T42N	R75W	43.5769	-105.8122
		006 EPTD	NWNE	36	T42N	R75W	43.5719	-105.8117
		007 EPTD	SWNE	36	T42N	R75W	43.5694	-105.8122
		008 EPTD	SESE	36	T42N	R75W	43.5639	-105.8008
		009 EPTD	NESW	24	T42N	R75W	43.59653	-105.81550
		010 EPTD	SWSW	31	T42N	R74W	43.5626	-105.8043
		011 EPTD	NESW	34	T42N	R75W	43.5647	-105.8586
		012 EPTD	SWSE	34	T42N	R75W	43.5647	-105.8547
		017 EPTD	NESE	27	T42N	R75W	43.5814	-105.8465
		019 EPTD	NWNW	35	T42N	R75W	43.5743	-105.8430
		020 EPTD	SENW	35	T42N	R75W	43.5688	-105.8374
		021 EPTD	NESW	35	T42N	R75W	43.5657	-105.8259
		022 EPTD	SWSE	35	T42N	R75W	43.5628	-105.8345
		023 EPTD	SWSE	35	T42N	R75W	43.5623	-105.8345
		024 EPTD	SWSE	23	T42N	R75W	43.59174	-105.83319
		025 EPTD	SESE	26	T42N	R75W	43.5775	-105.8261
		026 EPTD	SWSW	25	T42N	R75W	43.5763	-105.8227
		027 EPTD	NENW	36	T42N	R75W	43.5738	-105.8176
		030 EPTD	NENW	10	T41N	R75W	43.5442	-105.8581
BBC	WY0051217	018	NWSW	1	T41N	R75W	43.55252	-105.82161
		020	SWSE	2	T41N	R75W	43.54840	-105.83423
		021	SWSW	2	T41N	R75W	43.54722	-105.84404
BBC	WY0055131	004	NWNE	9	T41N	R75W	43.54492	-105.87229
		005	NESE	28	T42N	R75W	43.58020	-105.86910
		006	SWSW	28	T42N	R75W	43.57640	-105.88350
		007	SWSE	31	T42N	R75W	43.56395	-105.91549

		008	NESW	33	T42N	R75W	43.56641	-105.87995

*Shading indicates outfalls that are upstream of Moore Ranch License Area

Discharge data and WYPDES permit limits for outfalls located within the license area are provided in the tables on the following pages. Data provided in response to comment 2-5.b indicates that infiltration to the 72 Sand has not occurred to date.

A conservative annual declination rate of 5% is assumed for future CBM discharge based on Devon's East Pine Tree Unit (WY0040436) historic data, as presented in the following Tables 2.7.1-9 through 2.7.1-12. All three WYPDES permits will be up for renewal in early 2009 with an expiration date in 2014. Personal communications with permit holders indicates that the permits will not likely be renewed in 2014. Flow from Devon's WY0040436 outfalls is anticipated to be less than 0.006 MGD by 2013. Based on historic CBNG water discharge data within the license area, water quality will not vary significantly as CBNG water production declines.

Table 2.7.1-9 Historic and Projected Discharge Rates at CBM Discharge Points (Devon – East Pine Tree Unit, WY0040436)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2012	2014
Maximum Flow (MGD)	0.1006	0.0694	0.0572	0.0302	0.0183	0.0111	0.0092	0.0120	0.0114	0.0108	0.0103	0.0093	0.0084
Average Flow (MGD)	0.0895	0.0615	0.0388	0.0243	0.0143	0.0078	0.0078	0.0082	0.0078	0.0074	0.0070	0.0063	0.0057
Annual Decline		36.0%	35.2%	11.1%	11.1%	17.4%	5.9%	5.9%	5.0%	5.0%	5.0%	5.0%	5.0%

Table 2.7.1-10 BBC Pine Tree Area (WY0055131) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL				
			004	005	006	007	008
Total Flow (MGD) - MAX	MGD	1.02	0.0042	0.0261	0.0146	No Dis	No Dis
Total Flow (MGD) - AVG	MGD		0.0028	0.0197	0.0124	No Dis	No Dis
Bicarbonate	mg/L		952	1293	1126	No Dis	No Dis
Dissolved Calcium	me/L		74	82	73	No Dis	No Dis
Dissolved Magnesium	me/L		26	33	34	No Dis	No Dis
Dissolved Sodium	me/L		222	305	197	No Dis	No Dis
pH	SU	6.5-9.0	7.57	7.55	7.43	No Dis	No Dis
Sodium Adsorption Ratio	Calculated	10	5.7	7.6	6.0	No Dis	No Dis
Specific Conductance	micromhos/cm	2000	1350	1686	1415	No Dis	No Dis
Total Alkalinity	mg/L as CaCO3		780	1059	922	No Dis	No Dis
Chlorides	mg/L	46	10.3	6.9	6.8	No Dis	No Dis
Dissolved Iron	ug/L	1000	160	1257	570	No Dis	No Dis
Total Recoverable Arsenic	ug/L	3	0.67	1.73	1.60	No Dis	No Dis
Total Recoverable Barium	ug/L	1800	1050	2023	1157	No Dis	No Dis
Dissolved Cadmium	ug/L		0.1	ND	N/A	No Dis	No Dis
Dissolved Manganese	ug/L		97	104.5	84.5	No Dis	No Dis
Fluorides	mg/L		0.56	0.90	0.66	No Dis	No Dis
Potassium	mg/L		9	12.3	12.4	No Dis	No Dis
Sulfates	mg/L		2.6	3	7.5	No Dis	No Dis
Total Petroleum Hydrocarbons	mg/L		1	ND	ND	No Dis	No Dis
Total Radium 226	pCi/L		0.6	1.05	0.4	No Dis	No Dis

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

Table 2.7.1-11 Devon East Pine Tree Unit (WY0040436) WYPDES Average Water Quality and Discharge Rates[1]

PARAMETER	UNIT	PERMIT LIMIT[2]	OUTFALL 004	005	006	007	008	010	011	012	013	017	018	019	020	021	022	023	025	026	027	030
Flow - MAX	MGD	0.68	0.0443	0.0239	0.0109	0.0213	0.0256	0.0348	0.0283	0.0290	No Dis	0.0414	No Dis	0.0183	0.0086	0.0041	0.0066	No Dis	0.0130	0.0057	0.0032	0.0175
Flow - AVG	MGD		0.0367	0.0150	0.0096	0.0206	0.0232	0.0266	0.0217	0.0135	No Dis	0.0291	No Dis	0.0158	0.0076	0.0021	0.0044	No Dis	0.0108	0.0046	0.0021	0.0139
Alkalinity	mg/L		468	615	762	670	663	572	1217	995	No Dis	997	No Dis	602	702	498	434	No Dis	796	302	407	617
Total Recoverable Arsenic	ug/L	2.4	0.8	1.4	0.9	1.6	1.3	1.4	2.6	1.4	No Dis	5.6	No Dis	0.5	2.1	2.0	0.6	No Dis	0.6	1.6	1.1	1.8
Total Recoverable Barium	ug/L	1800	628	1032	1092	902	883	486	2476	1694	No Dis	1433	No Dis	577	925	600	421	No Dis	1153	296	360	980
Bicarbonate	mg/L		660	741	921	817	804	695	1471	1190	No Dis	1211	No Dis	723	828	605	517	No Dis	960	365	496	741
Calcium	mg/L		29	42	52	51	46	36	131	103	No Dis	88	No Dis	55	54	36	28	No Dis	68	17	26	59
Chlorides	mg/L	46	10	9	9	10	9	10	8	11	No Dis	5	No Dis	5	5	7	8	No Dis	6	9	No Dis	9
Dissolved Iron	ug/L	1000	189	482	1043	1089	60	671	380	174	No Dis	353	No Dis	467	351	1060	90	No Dis	498	892	905	0
Dissolved Cadmium	ug/L		N/A	N/A	N/A	N/A	N/A	N/A	0.6	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1820
Dissolved Manganese	ug/L		109	50	66	176	50	143	117	114	No Dis	77	No Dis	48	70	61	30	No Dis	88	119	74	57
Fluorides	mg/L		0.6	0.5	0.5	0.7	1.4	0.7	0.6	0.5	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.7
Magnesium	mg/L		8	9	16	11	13	9	44	29	No Dis	32	No Dis	16	14	8	6	No Dis	16	4	5	19
pH	SU	6.5 – 9.0	7.81	7.87	7.76	7.69	7.81	7.64	7.44	7.62	No Dis	7.55	No Dis	7.51	7.34	7.05	7.60	No Dis	7.16	7.66	7.22	7.84
Potassium	mg/L		5	6	7	7	7	6	15	11	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9
Sodium	mg/L		146	215	256	221	231	199	305	274	No Dis	298	No Dis	209	232	180	160	No Dis	255	117	153	178
Sodium Adsorption Ratio	Calculated	10	7.6	7.9	8.0	7.6	7.9	8.1	5.9	6.2	No Dis	7.0	No Dis	6.4	7.2	7.1	6.9	No Dis	7.2	6.7	7.2	5.1
Specific Conductance	umhos/cm	2000	859	1093	1348	1204	1175	1008	2068	1665	No Dis	1684	No Dis	1145	1186	912	798	No Dis	1316	585	735	1076
Sulfates	mg/L		13	2	4	3	2	2	5	2	No Dis	1	No Dis	40	1	1	8	No Dis	16	9	ND	2
Total Petroleum Hydrocarbons	mg/L		0.7	1.0	1.0	0.7	1.0	0.5	1.0	1.0	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0
Total Radium 226	pCi/L		0.5	0.3	0.5	0.3	0.3	0.3	0.8	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5

[1] – Data is provided for outfalls within the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0040436 (total number outfalls is 30)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

Table 2.7.1-12 BBC Palm Tree Project (WY0051217) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL		
			018	020	021
Total Flow (MGD) - MAX	MGD	5.3	0.0403	0.0079	0.0083
Total Flow (MGD) - AVG	MGD		0.0147	0.0079	0.0083
Bicarbonate	mg/L		723	744	674
Dissolved Calcium	me/L		5.72	7.89	11.78
Dissolved Magnesium	me/L		1.97	2.14	2.96
Dissolved Sodium	me/L		40.30	43.88	48.96
pH	SU	6.5-9.0	8.03	8.03	7.94
Sodium Adsorption Ratio	Calculated	10	7.9	7.4	6.4
Specific Conductance	micromhos/cm	2000	880	1052	967
Total Alkalinity	mg/L as CaCO3		449	615	555
Chlorides	mg/L	46	9	8	9
Dissolved Iron	ug/L	1000	1810	1514	2020
Dissolved Manganese	ug/L		63	119	66
Sulfates	mg/L		18	1	ND
Total Recoverable Arsenic	ug/L	3	0.8	1.0	1.6
Total Recoverable Barium	ug/L	1800	608	713	832
Total Petroleum Hydrocarbons	mg/L		ND	ND	ND
Total Radium 226	pCi/L		0.36	0.47	0.23

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
ND – Reported as non-detect by laboratory

The seasonal variability of surface water quality apparent during baseline characterization (see section 2.7.3.1) is largely due to the influence from Devon Energy's outfalls permitted under WY0040436. The lack of water at MRSW-10 and MRSW-11 indicates that Bill Barrett's discharges upstream infiltrate into the shallow alluvial system and do not directly contribute to surface hydrological features within the license area. Assessment of surface water quality in light of the contributions from CBNG water discharges present at or upstream of monitoring sites must account for the seasonal variability present in the area. Following permit renewals in late summer/early fall 2008, WYPDES permits WY0040436, WY0051217 and WY0055131 will be active into 2014.

2.7.2 Groundwater

This section describes the regional and local groundwater hydrology, including hydrostratigraphy, groundwater flow patterns, hydraulic gradient and aquifer parameters. The discussion is based on information from investigations performed within the Powder River Basin, data presented in previous applications and reports for the Moore Ranch Site, and the geologic information presented in Section 2.6. Regional and site baseline water quality conditions and local groundwater use are discussed in Sections 2.7.3 and 2.7.4, respectively of this application.

2.7.2.1 Regional Hydrogeology

The Moore Ranch site is located in the southwestern portion of the Powder River Basin, approximately 20 miles east of the north-flowing Powder River and approximately 50 miles north of Casper, Wyoming. Moore Ranch lies within the Northern Great Plains Aquifer System (USGS 1996). The Northern Great Plains Aquifer System contains overlapping aquifers in the Lower Tertiary, Upper and Lower Cretaceous, and Upper and Lower Paleozoic rocks. Figure 2.7.2-1 provides a generalized stratigraphic column of the hydrostratigraphic units of the Northern Great Plains Aquifer System. The Eocene Wasatch Formation, the stratigraphic unit that hosts the uranium mineralization of the Moore Ranch project, crops out over most of the License area (and most of the central portion of the Powder River Basin). The Oligocene White River Formation, which is commonly found in outcrop along the fringes of the Powder River Basin, has been eroded away in the Moore Ranch area. Occasional surficial deposits of the White River Formation are encountered in the vicinity of Pumpkin Buttes (north of the site), but these deposits are not a significant source of groundwater. Furthermore, Rankl and Lowry (1990) state that water from Quaternary alluvium in the Powder River Basin has not been developed extensively because better quality water occurs in the underlying Lower Tertiary and Upper Cretaceous (Wasatch-Fox Hills) sequence and large yields are generally not possible.

The Lower Tertiary aquifers are found within the Wasatch and Fort Union Formations, and the Upper Cretaceous aquifers are found within the Lance Formation and the Fox Hills Sandstone. The Lower Tertiary-Upper Cretaceous aquifer sequence (Wasatch to Fox Hills Sandstone) is about 1,350 feet thick in southeastern Montana and thickens to at least 7,000 feet in Converse County (south of the Moore Ranch Site) (Taylor 1968). The Lewis Shale is a regional aquitard that separates the Upper Cretaceous aquifers from the Lower Cretaceous aquifers.

The Lower Cretaceous aquifers include the Mesa Verde, Frontier and Cloverly Formations. Several regional aquitards are interlayered between these Cretaceous aquifers, including the Cody, Mowry and Thermopolis Shales. Figure 2.7.2-1 shows the stratigraphic relationship of the Lower Teritiary, Upper and Lower Cretaceous aquifers and the regional aquitards for the western portion of the Powder River Basin.

Historical studies have stated that regional groundwater systems (e.g., the Wasatch, Fort Union, and deeper aquifers) generally flow to the northern portion of the Powder River Basin and discharge via unknown locations in Montana (Lowry & Wilson, 1986, and Rankl & Lowry, 1990). A generalized potentiometric surface map for the Lower Tertiary units of the Northern Great Plains Aquifer system is shown in Figure 2.7.2-2. The hydraulic communication between the aquifer systems has been reported to vary from none to direct. Groundwater flow direction in sediments near outcrop areas generally has been characterized as toward the center of the Powder River Basin.

On a semi-regional scale, groundwater flow occurs to the north-northwest, and the gradient is on the order of 0.004 to 0.006 ft/ft. This groundwater flow direction is consistent with results of numerous studies (Honea, 1974; Morris & Bahr, 1975; NRC, 1978; Rose, 1971). In the vicinity of Moore Ranch, flow in the shallow groundwater system is north to northwesterly, toward the Powder River.

Regional recharge to the Lower Tertiary aquifers in the vicinity of the Moore Ranch Project generally occurs at the formation outcrops along the western and southern edges of the Powder River Basin, associated with the Casper Arch and Laramie Mountain uplifts. Some recharge to the shallower aquifer systems is also derived from localized infiltration of precipitation. As described under the section on geology, sands that contain the uranium mineralization at Moore Ranch (70 Sand) crop out within a mile to the southeast of the License Area. These outcrops are localized recharge zones for the Wasatch aquifers within the Moore Ranch License Area.

For purposes of this application, only hydrogeologic units of Lower Tertiary/Upper Cretaceous age are described with respect to general hydrologic properties and potential for groundwater supply. Units deeper than the Fox Hills Sandstone and beneath the Lewis Shale are generally too deep to economically develop for water supply or have elevated TDS concentration that renders them unusable for consumption. Exceptions to this can be found along the edges of the basin, where Lower Cretaceous and older stratigraphic units are found in outcrop. Near outcrop areas, Lower Cretaceous and Paleozoic units can provide relatively good quality water. In particular, the Mesaverde Formation, Frontier Formation, Madison Limestone and Tensleep Sandstone can produce large quantities of relatively good quality water. However those outcrop locations are tens of miles from the Moore Ranch site. In the vicinity of Moore Ranch, the Lower Cretaceous and Paleozoic rocks are separated from the Wasatch Formation by over 5,000 feet of sediments.

Units younger than Lower Tertiary are typically not present within the vicinity of Moore Ranch and therefore are of no significance with respect to groundwater supply. Hydrologic units of interest within the southwest Powder River Basin are shown on the stratigraphic column in Figure 2.7.2-1 from deepest to shallowest:

- Lewis Shale (Late Cretaceous)
- Fox Hills Sandstone (Late Cretaceous)
- Lance Formation (Late Cretaceous)
- Fort Union Formation (Paleocene)
- Wasatch Formation (Eocene)

Discussion of the regional characteristics for each of these hydrostratigraphic units is provided below.

Lewis Shale

The Lewis Shale underlies the Fox Hills Sandstone and is generally considered the major aquitard between the Upper and Lower Cretaceous aquifer systems in the Powder River Basin. This unit is described by Hodson et al. (1973) as predominately shale with sandy shale zones and lenses of fine-grained sandstone. Thickness of this unit is approximately 450 to 500 feet in the southwest part of the basin. Small quantities of water may be available from the thin sandstone beds within this unit near the margins of the basin. However most of this formation does not yield water (Hodson 1973).

Fox Hills Sandstone

The Fox Hills Sandstone is the basal aquifer unit within the Lower Tertiary/Upper Cretaceous aquifer sequence in the Powder River Basin. The Fox Hills Sandstone consists of fine to medium grained sandstone beds deposited in a marine environment. The Fox Hills Sandstone is described by Weimer (1961) as a lithogenetic unit consisting of a series of individual sands bodies, sometimes several miles wide and hundreds of miles long. The Fox Hills Sandstone has been recognized in the northwestern part of the basin, but is generally poorly developed and unmapped along the western side of the basin (Gill 1966). The Fox Hills Sandstone is approximately 700 feet thick in the west part of the basin (Horn 1955) but is often undifferentiated from the overlying Lance Formation in west and northwest parts of the basin (Hose1955).

Because of the disconnected nature of the individual sand bodies, hydraulic head data is not sufficient to define a potentiometric surface for a specific horizon within the Fox Hills Sandstone (Rankl 1990). Wells completed in the Fox Hills Sandstone have yields that typically range from 5 to 50 gallons per minute. Locally, this formation can yield over 200 gallons per minute, although lower yields are typically available in the western portion of the basin (Hodson 1973). Flowing artesian conditions (75 gpm) were present in a well in Campbell County, completed at a depth of 2,000 feet.

Lance Formation

Overlying the Fox Hills Sandstone is the Lance Formation. The Lance Formation consists predominately of very fine-to fine-grained lenticular, clayey, calcareous sandstone. Shale, coal and lignite beds are present within the formation, which has a typical thickness of 1,000 to 3,000 feet (Conoco 1982). Wells completed in the Lance Formation generally yield less than 20 gpm and most wells are drilled in outcrop areas for domestic and stock purposes. Because few wells are completed in this formation out toward the center of the basin, potentiometric surface data are limited. It is assumed that the direction of groundwater flow is generally to the north, similar to that of the overlying Fort Union and Wasatch Formations.

Fort Union Formation

The Paleocene Fort Union Formation is stratigraphically between the Lance Formation and the overlying Wasatch Formation, reaching a maximum thickness of approximately 3,500 feet within the Powder River Basin. The Fort Union Formation is described as continental and shallow non-marine deposits of sandstone, carbonaceous shale and coal. Outcrops of the Fort Union Formation encircle most of the basin and the beds dip basinward. This formation is a major source of coal within the Powder River Basin and the United States and is extensively exploited for coal bed methane reserves.

Water is generally produced from sandstone, jointed coal and clinker beds with maximum yields on the order of 150 gpm. Specific capacities determined from wells completed in the Fort Union Formation within the Powder River Basin are generally less than 1 gpm per foot of drawdown (Lowery 1966, and Whitcomb 1964).

The hydraulic gradient of the Fort Union and Wasatch aquifers in the vicinity of Moore Ranch is reported as 0.0014 ft/ft to the north-northwest by Conoco (1982).

Wasatch Formation

The Wasatch Formation is described as an arkosic fine- to coarse-grained sandstone with siltstone, claystone and coals. The Wasatch Formation was deposited as a mixture of alluvial, fluvial and paludal environments. The contact between the Fort Union Formation and the Wasatch Formation is gradational in the vicinity of Moore Ranch and is generally arbitrarily set at the top of the thicker coals or thick sequence of clays and silts (Conoco 1982). The boundary between the two formations was considered by Conoco to be the top of the Roland Coal. Maximum total thickness of the Wasatch Formation is greater than 1,000 feet (800 to 1,100 feet in the License Area). In the southern portion of the Powder River Basin, the Wasatch Formation generally dips to the northwest at 1.0 to 2½ degrees. The sandstones that contain the uranium mineralization are generally coarse cross-bedded arkosic sand deposited in a high-energy fluvial environment. Individual channel sand units are generally oriented northward.

There are commonly multiple water-bearing sands within the Wasatch Formation. Groundwater within the Wasatch aquifers is typically under confined (artesian) conditions, although locally unconfined conditions exist. Hodson et al (1973) reported that wells completed in the Wasatch typically yield 10 to 50 gpm in the north part of the basin but yields are generally greater in the south part of the basin with yields as high as

500 gpm possible. Specific capacities of wells completed in the Wasatch Formation are usually greater than for wells completed in the underlying aquifers. Specific capacities of 4 to 15 gpm/ft of drawdown were reported by Hodson et al. (1973).

As reported by Rankl and Lowry, most data available to describe aquifers in the Wasatch/Fox Hills sequence are from stock and domestic wells that are generally completed in small intervals of single formations at depths of less than 500 feet. There is large topographic relief in the area and because these wells are completed in sandstone aquifers at differing depths, hydraulic head data are generally not representative of a single continuous stratigraphic horizon and are not sufficient to provide potentiometric surfaces extending over great distances. The overall groundwater flow system in the shallow aquifers in the vicinity of Moore Ranch is toward the Powder River to the north-northwest. However, the aquifer systems are often locally controlled by stratigraphy and topography and attempts to confidently extend potentiometric surface data for any significant distance is difficult.

2.7.2.2 Site Hydrogeology

Groundwater

EMC has been collecting lithologic, water level, water quality, and pump test data as part of its ongoing evaluation of hydrologic conditions at the Moore Ranch Project. In addition to recent data acquisition, historic data collected for Conoco (1982) was used to support this evaluation. Drilling and installation of borings and monitor wells is ongoing in order to provide additional data to further refine the site hydrologic conceptual model. Water level measurements, both historic and recent, provide data to assess potentiometric surface, hydraulic gradients and inferred groundwater flow directions for the aquifers of interest at the Moore Ranch Project, at least on a localized scale. Recently completed pump tests by EMC and Petrotek Engineering Corporation (PEC 2007) as well as the pump tests conducted by Conoco (1982), were used to evaluate hydrologic properties of the aquifers of interest and to assess hydraulic characteristics of the confining units.

Figure 2.7.2-3 shows the monitor wells (current and historic) that were used in the site hydrologic evaluation. Table 2.7.2.1 provides data for those wells to the extent available.

Hydrostratigraphic Units

EMC has adopted the nomenclature used by Conoco (1982) for the hydrostratigraphic units of interest within the Moore Ranch Project. Sands above the Roland Coal are numbered, increasing upward. The 40 and 50 Sands are regionally extensive sands that are considered significant aquifers. The primary Production Zone is identified as the 70 Sand. The 70 Sand is bounded above and below by areally extensive confining units.

Overlying the upper confining unit is the 72 Sand. The 72 Sand is considered the overlying aquifer to the Production Zone. The shallowest occurrence of groundwater within the License area occurs within the 72 Sand. Beneath the lower confining unit is the 68 Sand. Although the 68 Sand is considered the underlying aquifer to the Production Zone, it is in communication with the 70 Sand in parts of the License Area. The 68 Sand also appears to coalesce with the underlying 60 Sand in portions of the License Area. Figure 2.7.2-4 depicts the hydrostratigraphic relationship of these units.

A brief description of each hydrostratigraphic unit follows, from shallowest to deepest.

72 Sand (Overlying Aquifer)

The 72 Sand (overburden above the 70 Sand) consists of a 50- to 250-foot thick sequence of clays, silts, discontinuous sandstones and alluvial sediments. The alluvial sediments are limited to the low-lying areas of surface drainages. A lignite marker bed, designated the "E" coal, is present across the site below the 72 Sand. As previously described, the 72 Sands are discontinuous and, when saturated, generally represent perched water conditions. Figure 2.6-12 is an isopach of the overburden thickness in the vicinity of the ore bodies. The 70 Sand is considered the uppermost continuous water-bearing unit within the License area.

The first potential aquifer overlying the Production Zone is the 72 Sand. The top of the 72 Sand occurs at depths of approximately 30 to 200 ft below ground surface (bgs) within the Moore Ranch License Area. The total thickness of the sand ranges from 5 to 90 feet. This sand is discontinuous across the License area, pinching out to the west-southwest. The 72 Sand is unsaturated over the southern portion of the License Area. In areas that saturated conditions exist within the 72 Sand, this unit is considered the overlying aquifer to the Production Zone aquifer.

Upper Mudstone, E Coal and Lower Mudstone-Upper Confining Unit

Underlying the 72 Sand is a sequence of mudstone, shale and lignite. A persistent, laterally extensive lignite seam was identified by Conoco as the E Coal. The E Coal is located a few feet above the top of the 70 Sand and is a consistent marker bed for the License Area. The units above and below the E Coal were designated by Conoco as the Upper and Lower Mudstone, respectively. The sequence of Upper Mudstone, E Coal and Lower Mudstone are collectively considered the Upper Confining Unit to the Production Zone. Although the E Coal has some intrinsic permeability, its limited thickness (typically 3 feet or less) and limited extent of saturation precludes its use as a source of groundwater supply.

In some instances, saturated conditions have been found to exist in wells completed in shallower sands above areas where the upper portion of the 70 Sand is unsaturated indicating that, at least locally, perched water is present.

70 Sand (Production Zone Aquifer)

The 70 Sand contains uranium mineralization and is the production zone at the Moore Ranch Project. The total thickness of the 70 Sand ranges from 40 to 120 feet, but is typically 60 to 80 feet, (Figure 2.6-9). The top of the 70 Sand ranges from approximately 100 to 330 ft bgs within the Moore Ranch License Area. This hydrostratigraphic unit is areally extensive (except to the south where it crops out) and dips to the northwest at less than one degree. The 70 Sand is present in outcrop or under a thin veneer of alluvium and topsoil just south of the License area over large portions of section 11 and 12 of T41N and R75W and Sections 6 and 7 of T41N and R74W. The area of 70 Sand outcrop is a recharge zone for the production zone aquifer. Water entering the 70 Sand in this recharge area would flow north-northwest across the License Area.

The 70 Sand aquifer occurs generally under unconfined conditions in the project area. The 70 Sand aquifer in Wellfields #1 and #3 occurs mostly under unconfined conditions and has adequate hydrostratigraphic confinement between the production sand and/or the overlying/underlying sands. In Wellfield #2, the 70 Sand aquifer occurs under unconfined conditions and for the most part has adequate hydrostratigraphic confinement between the 70 Sand and overlying/underlying sands. However, lack of hydrostratigraphic confinement between the 70 Sand and the underlying 68 Sand occurs in the eastern/northeastern part of Wellfield #2. Additional mine-unit scale testing will provide data necessary to validate the approach for mining and monitoring this section of Wellfield #2. In the south part of the License Area, the 70 Sand is the shallowest occurrence of groundwater (although perched conditions may exist locally in some of the overlying sands and coals). The underlying aquifer to the 70 Sand is the 68 Sand.

Lower Confining Unit

Beneath the 70 Sand is a sequence of clays and silts ranging from 0 to 50 feet thick. The clay/silt sequence is absent in the area of monitor well UMW-2 where the 70 and 68 Sands coalesce.

68 Sand (Underlying Aquifer)

The 68 Sand is present beneath the Lower Confining Unit and in some areas in contact with the 70 Sand. The 68 Sand is typically 40 to 60 feet thick but can reach over 75 feet in thickness (Figure 2.6-8).

Unnamed Shale Unit

The unnamed shale at the base of the 68 Sand has not yet been fully characterized. This unit is generally 5 to 30 feet thick.

60 Sand

The 60 Sand is generally the first sand unit underlying the 68 Sand. In areas where the 70 and 68 Sand coalesce as one aquifer, the 60 Sand is considered the underlying aquifer to the production zone aquifer. The 60 Sand is approximately 100 feet thick and is continuous throughout the area. It is separated from the underlying 50 sand by about 80 feet of shale or mudstone with some interspersed sandstone lenses. Additional borings are being drilled to evaluate the geologic and hydrologic characteristics of this hydrostratigraphic unit.

Potentiometric Surface, Groundwater Flow Direction and Hydraulic Gradient

The EMC hydrologic evaluation of the Moore Ranch Project included measurement of water levels in monitor wells completed in the 70 Sand (production zone), the overlying aquifer (72 Sand) and the underlying aquifer (68 Sand) to assess the potentiometric surface, groundwater flow direction and hydraulic gradient of those units. Additional historic water level data were available from the Conoco hydrologic evaluation of the site (1982). Table 2.7.2-2 lists water level data recorded for the site monitor wells.

The potentiometric surface for the production zone is shown on Figures 2.7.2-5a through 2.7.2-5e. The figures show a consistent hydraulic gradient toward the north throughout the period of measurement (February 2007 through March 2008) with the exception of the July 2007 potentiometric surface map. The potentiometric surface in July 2007 (Figure 2.7.2-5c), indicates a depression at baseline well MW8. Hydrographs have also been prepared for all of the baseline monitor wells completed within the 70 Sand that illustrate water level fluctuations since the wells were installed in 2006 (Figures 2.7.2-5f and 2.7.2-5g). Water level fluctuations are generally less than a few feet with the exception of monitor well MW8. MW8 showed a decrease of almost 20 feet in two measurements in July 2007 and then rebounded to previous levels. No direct cause has been identified for the decrease although it is suspected that the low water level is the result of slow recovery after purging the well prior to a sampling event. A potentiometric map was also constructed for the July 2007 data without including the MW8 measurement (Figure 2.7.2-5h). The results of the mapping indicate that the depression around MW8 is localized and does not impact the other baseline wells. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2. Based on those data, the direction of groundwater flow within the 70 Sand is predominantly to the north, generally consistent with the regional flow system. The horizontal hydraulic gradient calculated from this data is approximately 0.0040 ft/ft (21.1 ft/mile).

Hydrographs of the 72 Sand baseline monitor wells indicate minimal change in the water level elevations within that hydrostratigraphic unit since the wells were installed in 2006 (Figure 2.7.2-6a). Water level data used to develop the hydrographs are included in Table 2.7.2-2. Saturated thickness of the 72 Sand ranges from 10 feet at OMW2 to over 50 feet at OMW1. Additional potentiometric maps of the 72 Sand have been prepared and are attached (Figure 2.7.2-6b through 2.7.2-6f). The figures illustrate that the potentiometric surface is relatively stable throughout the period of measurement (February 2007 through March 2008). Water levels collected from the overlying aquifer (72 Sand) in indicate a similar northerly groundwater flow direction as for the 70 Sand aquifer. The horizontal hydraulic gradient calculated from the data for the 72 Sand aquifer is approximately 0.0039 ft/ft (20.4 ft/mile).

Potentiometric surface maps for the 68 Sand are attached (Figures 2.7.2-7a through 2.7.2-7e). The maps show that the horizontal hydraulic gradient is consistently toward the northwest, however the magnitude of the gradient varies. Changes in the horizontal hydraulic gradient are predominately caused by large fluctuations in water levels that occur in 68 Sand monitor well UMW3. Additional monitoring of that well was performed by EMC and is described in detail later in this section. Hydrographs have been prepared for the baseline monitor wells showing water level changes over time for each well (Figure 2.7.7-7f). With the exception of well UMW3, water levels remain relatively stable during the period of measurement (February 2007 through March 2008). Comparison of water levels in each of the nested well groups (MW1/UMW1 through MW4/UMW4) are shown on Figures 2.7.2-7g through 2.7.2-7j respectively. Water levels between the MW1/UMW1 and MW2/UMW2 well groups are very similar and no clear vertical hydraulic gradient predominates. The data are consistent with isopach data that indicate the absence of the underlying shale between the 70 and 68 Sands in the eastern portion of Wellfield 2 and therefore possible hydraulic communication between those units. At the MW4/UMW4 well group there is a distinct downward hydraulic gradient between the 70 and 68 Sands with water levels in the 70 Sand monitor wells consistently 8 to 10 feet greater than in the 68 Sand monitor wells. The hydraulic relationship between the 70 and 68 Sands at the MW3/UMW3 well pair is not clear because of the large fluctuations in water levels at UMW3, as described later in this section. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2. Although the general direction of groundwater flow is also to the north, the horizontal hydraulic gradient calculated for the 68 Sand (0.0005 ft/ft [2.6 ft/mi]), is much flatter than for the 70 and 72 Sands.

Vertical hydraulic gradients were determined by measuring water levels in closely grouped wells completed in different hydrostratigraphic units. Figure 2.7.2-8 shows the location of the well groups used for the assessment of vertical hydraulic gradients. Table 2.7.2-3 summarizes the calculated vertical gradients between the 72, 70 and 68 aquifers. The potentiometric surface of the 70 Sand ranges from 50 to 60 feet lower than the potentiometric surface of the overlying 72 Sand at the grouped wells, suggesting that the overlying aquifer and the production zone aquifer are not in hydraulic communication. Vertical hydraulic gradients range from approximately 0.6 to 0.9 ft/ft between the 72 and 70 Sand aquifers and consistently indicate decreasing hydraulic head with depth (downward potential). A downward potential is indicative of an area of recharge, as opposed to an upward potential that is normally indicative of an area of groundwater discharge.

The vertical gradient between the 70 and 68 Sand aquifers is minimal at two of the well groups (MW1 and MW2). There may be hydraulic communication between the aquifers at these locations. This is consistent with earlier observations that the 68 and 70 Sands coalesce in places within the License Area. At the MW4 well group, there is a 5 to 10 foot head difference between the 70 and 68 Sand aquifers (decreasing with depth). In the area of the MW4 well group, the shale unit between the 70 and 68 Sand is 25 to 40 feet thick. The thickness of the shale unit, coupled with the large head difference indicates that the 68 and 70 Sand aquifers are not in direct hydraulic communication at this location. The vertical hydraulic gradient between the 68 and 70 Sand aquifers is variable at the MW3 well group location. Recent data, collected in June and July of 2007, indicate that the potentiometric heads are higher in the 70 Sand aquifer (at well MW3) by 10 to 20 feet. Data collected in February 2007 indicated the potentiometric heads in the 68 Sand aquifer (well UMW3) were higher than the heads in the 70 Sand aquifer by 7 to 10 feet.

The water levels in the 70 Sand aquifer remained relatively constant throughout the year but changed by as much as 25 feet in the 68 Sand aquifer at UMW3. The cause for the large fluctuation in water levels in the 68 Sand at well UMW3 is unknown. Well UMW-3 experienced steady drawdown since early February of 2007. Approximately 25 feet of water level decline was observed until mid-August, when the well began to show recovery trend with the water level rising approximately 10 feet. None of the other underlying 68 Sand wells in the project area showed this declining trend and only showed fluctuations of a few feet. Investigation has not revealed the cause of the declining water levels. . The unexplained drawdown observed in the water levels of UMW-3 from February through July of 2007 does not correspond with production from nearby CBNG wells. Production from the six closest wells was ongoing through both drawdown and subsequent recovery of the water levels in UMW-3. Water production from the CBNG wells in March 2008 was more than 5,780 bbls/day (WOGCC, 2008), while the water levels in UMW-3 stabilized in February 2008. The majority of this has come from the 34S-1 (NENE, Section 34, T42N, R75W) and 35S-4 (NWNW, Section 35, T42N, R75W). Impacts to the monitor well due to CBNG production seems highly unlikely given this scenario.

EMC has continued monitoring of UMW3 to determine if the drawdown behavior is repeated or if a cause of the observed trend can be identified. Water level measurements were made at 15 minute intervals using a pressure transducer from 2/15/07 through 3/1/07, and 3/20/07 through 3/23/07, and then at 10 minute intervals from 5/8/08 through 7/1/08. A problem was identified with the transducer during the 2008 monitoring period, resulting in replacement of the instrument. Hand measurements were periodically made throughout the monitoring period. A hydrograph is attached that shows the water level elevation during the entire monitoring period (Figure 2.7.2-7k). In addition to the decline in water levels that was previously noted in the Permit Application (from February 2007 until August 2007) a large decrease in water level occurred in the well in October 2007. The decrease in water levels was in response to a sampling event in which the well was purged prior to sampling. Almost two months following the sampling event, water levels in the well were still almost 18 ft lower than the pre sample level. This slow recovery indicates that the 68 Sand in the vicinity of UMW3 has a relatively low transmissivity or that there is significant skin damage in the well. Discounting the equipment malfunction (which was identified when hand measurements indicated an error in the transducer measurement) the water level in UMW3 has been relatively stable since February 2008. The cause of the earlier declining trend in the well is unknown and was not replicated in other wells. EMC will continue periodic monitoring of well UMW-3 to identify continuing trends and potential causes of those trends in the well. Additionally, the underlying aquifer in the vicinity of UMW-3 will be closely monitoring during production of the 70 Sand in that area.

Aquifer Properties

Hydrologic properties for the Wasatch aquifers within the Moore Ranch Project area are estimated from historic and recent pumping tests. Dames & Moore conducted an initial investigation (1978) for Conoco of the hydrologic properties within the Wellfield 1 and Wellfield 2 ore bodies. Conoco performed additional hydrologic evaluation in 1982 to determine the feasibility of in-situ and/or open pit production of those uranium ore bodies.

Historic Pump Tests

A series of aquifer tests were conducted on the Moore Ranch project from 1977 through 1980 to assess hydraulic characteristics of the production zone as well as overlying and underlying hydrostratigraphic units. Initial testing was performed by Wyoming Water Resources Research Institute (WWRI). Dames & Moore's assessment of the initial testing was that the results were unsatisfactory because of improperly developed wells, inadequate water level measurements and inappropriate analysis methods (Dames & Moore, 1978). Conoco redeveloped the wells using airlift pumping. Data collected during development of the wells were analyzed by Conoco to determine aquifer characteristics;

additional pump tests also were conducted and analyzed by Conoco. A summary of the Conoco tests that were conducted to assess conditions within the ore bodies at Moore Ranch is presented below (See Appendix B5 for Historic hydrologic analysis by Conoco). Information on the pumping wells and observation wells utilized in the pump tests are provided in Table 2.7.2-1 and the locations of the wells are shown on Figure 2.7.2-9.

- A pumping test was conducted on 8/17/77 at well 885 with wells 886, 887 and 888 as observation wells. These wells are located within the Wellfield 1 orebody. Well 885 was pumped for 1 day (1440 minutes) at a rate of 3.4 gallons per minute (gpm). Observation wells 886, 887 and 888 were located 64, 115 and 50 feet, respectively, from the pumping well. Drawdown in the observation wells at end of test for 886, 887 and 888 were 0.74, 0.76 and 1.94 feet, respectively. All wells are completed within the 70 Sand except for well 887, which is completed in the 68 Sand. The response of well 887 during the pumping test indicates the possibility that there is hydraulic communication between the 70 and 68 Sands in the vicinity of the Wellfield 1 orebody. The Conoco Mine Permit Application states that the seal between the sands in well 887 was questionable.

- The previously described wells were redeveloped using airlift methods. Recovery following redevelopment was recorded at wells 886 and 887. The effective pumping rate was 2 gpm for 886 and 0.1 gpm for 887 with 0.7 and 12 feet of drawdown, respectively.

- A pumping test was conducted within the Wellfield 2 orebody on 6/25/78. Well 1 was pumped at 3.5 gpm for 140 minutes. Observation wells 1805 and 1806, located 36 and 73 feet, respectively from the pumping well, had measured drawdown of 0.71 and 0.54 feet at the end of the test. The pumping well and the observation wells are all completed within the 70 Sand.

- A second pumping test was conducted at Well 1 on 6/25/78 to evaluate hydraulic communication with the 68 Sand within the Wellfield 2 orebody. Well 1 was pumped at 2.5 gpm for 170 minutes. Observation well 1807 is located 111 feet from pumping well and completed within the 68 Sand. Drawdown of 0.37 feet was measured at well 1807 at the conclusion of the pumping test. The test results indicate that there may be hydraulic communication between the 70 and 68 Sand within the Wellfield 2 orebody. However, the Conoco Mine Permit Application indicates the results are inconclusive based on concerns regarding the integrity of the well completion in 1807.

- Well 1814, located within the Wellfield 3 orebody, was pumped at 19 gpm for 1140 minutes beginning on 12/1/78. A maximum drawdown of 1.87 feet was measured at well 1816, located 55 feet from pumping well. Both the pumping and observation wells are completed within the 70 Sand.

- Well 1823 was pumped for 70 minutes at 1.7 gpm on 5/22/80. Well 1823 is located within the Wellfield 3 orebody and is completed in the 68 Sand. Over 6 feet of drawdown was measured in that well during the test. Water levels were also measured in observation well 1816 during the test. Well 1816 is located 70 feet from 1823 and completed in the 70 Sand. Water levels in well 1816 showed a slight increase during the pumping test, indicating a possible lack of hydraulic communication in that area between the 68 and 70 Sands.

- Well 1814, located in the Wellfield 3 orebody, was pumped at an average rate of 16.8 gpm over 3,100 minutes, beginning on 8/13/80. Maximum drawdown at the pumping well was 32 feet. The maximum drawdown in the well occurred approximately 1170 minutes into test. The pumping rate gradually decreased after that time (from 17.1 gpm to 15.8 gpm) and the water levels showed slight recovery during the latter portion of the test. Water levels were recorded during the test at observation wells 1816, 1815, 1817, and 1823, located 34.5, 89, 228 and 75 feet from the pumping well, respectively. All of the wells are completed in the 70 Sand except for 1823, which is completed in the 68 Sand. Maximum drawdown measured in the 70 Sand observation wells was 2.87 feet (1816), 1.3 feet (1815) and 0.2 ft (1817). Water levels in well 1823 did not show any drawdown, again indicating hydraulic separation between the 68 and 70 Sand in the vicinity of Wellfield 3 orebody.

Results of the tests were variable with the highest transmissivity and hydraulic conductivity values determined for the Wellfield 3 orebody. The results from the aquifer tests are summarized in Table 2.7.2.4. Based on internal review of the data by PEC, representative values are presented in the table along with the range.

Table 2.7.2-4 Summary of Conoco Pump Test Results – 68 and 70 Sand Moore Ranch Project		
	Range of Values	*Representative Value*
Wellfield 1-Orebody		
Transmissivity (T; ft^2/d)	23 to 240	110
Hydraulic Conductivity (k; ft/day)	0.38 to 4.0	1.9
Net Sand Thickness (h; ft)	60	60
Storativity (S)	5.3×10^{-6} to 2.9×10^{-3}	9.8×10^{-4}
Wellfield 2-Orebody		
Transmissivity (T; ft^2/d)	112 to 297	165
Hydraulic Conductivity (k; ft/day)	0.95 to 1.52	1.4 ft/d
Net Sand Thickness (h; ft)	80	80
Storativity (S)	8.0×10^{-5} to 5.2×10^{-4}	2.5×10^{-4}
Wellfield 3-Orebody		
Transmissivity (T; ft^2/d)	374 to 735 ft^2/d	555
Hydraulic Conductivity (k; ft/day)	9.35 to 18.3	13.8
Net Sand Thickness (h; ft)	40	40
Storativity (S)	3.2×10^{-4} to 4.3×10^{-3}	1.4×10^{-3}
Specific Yield	0.01 to 0.058	0.032

Note: The 70 Sand is only partially saturated in the vicinity of the Wellfield 3 ore-body

Additional testing was performed by Conoco in an area to the southeast that was selected as a potential site for evaporation ponds. The purpose of that testing was primarily to assess hydraulic characteristics of the near-surface soils with respect to suitability for pond placement.

Limited data (e.g., laboratory analyses or detailed pump test data) regarding the vertical hydraulic conductivity of the confining units are available for the Moore Ranch Project area. However, the data from other ISR operations in the Powder River Basin (COGEMA Mining Corporation and Power Resources Inc) appear to be reasonably analogous to Moore Ranch. In this regard, the COGEMA and PRI data indicate the vertical hydraulic conductivity of clays/shales in the Wasatch is on the order of 10^{-7} to 10^{-11} cm/sec (10^{-4} to 10^{-7} ft/d).

2007 Pump Tests

In February 2007, EMC and PEC initiated a pump test designed to accomplish the following objectives:

1. Demonstrate hydraulic communication between the production zone (70 Sand) pumping well and the surrounding monitor wells;

2. Assess the hydrologic characteristics of the production zone aquifer within the test area;

3. Evaluate the presence or absence of hydrologic boundaries in the production zone within the project area; and,

4. Demonstrate sufficient confinement between the production zone and the overlying and underlying sands for the purposes of ISR mining.

The limited historic data (Conoco) suggested it might be possible to test the entire Moore Ranch Project Area in one test (e.g., by pumping from only one well). For this reason, the pumping well (PW-1) was centrally located between the ore bodies and installed specifically for use as a pumping well. However, based on the results from the first test that indicated greater than anticipated transmissivity and hydraulic conductivity, two additional pump tests were conducted. Table 2.7.2.1 provides basic well information for the pumping wells and observation wells used in the tests. Table 2.7.2.5 summarizes the pump test parameters. The location of pumping wells and observation wells are provided in Figure 2.7.2.10. Details regarding the pump test procedures and results are provided in Appendix B1.

Table 2.7.2-5 Summary of Moore Ranch 2007 Pump Test Parameters

Test No.	*Pumping Well*	*Duration (minutes)*	*Duration (days)*	*Flow Rate (gpm)*	*Comments*
1	PW-1	14,285	9.9	15.6	20.6' drawdown in PW1; only other response observed was in MW-1 (distance of 109')
2	MW-2	1,465	1.0	26.0	19.4' drawdown in MW-2; response in Well 1805 (70 Sand, distance of 346'); UMW-2 (68 Sand; distance of 10'), 1807 (68 Sand; distance of 252')
3	MW-3	5,535	3.8	14.4	17.8' drawdown in MW-3; no response in any other monitor wells

Transmissivity (T) results from the analysis for the 70 Sand range from 321 to 711 ft^2/d, with an average value of 586 ft^2/d. Based on an average thickness of 80 feet, the average hydraulic conductivity (K) is 7.3 ft/d. Assuming a water viscosity of 1.35 cp (50 degrees F) and a density of 1.0, this equates to a permeability of approximately 2,000 millidarcies (md). The only storativity (S) was obtained from MW-1 at a value of 4.4×10^{-3}. Details of the methods of analysis of the pump tests and the results are discussed in Appendix

B1. Table 2.7.2-6 provides a summary of the aquifer properties estimated from the recent pump test results.

Table 2.7.2-6 Summary of Aquifer Properties Estimated From Recent Pump Test Results

Pump Test	Representative Value
Central Location Between Wellfields 1, 2 and 3 (PW-1 Test)	
Transmissivity (T; ft2/d)	656.5
Hydraulic Conductivity (k; ft/day)	8.87
Net Sand Thickness (h; ft)	77
Storativity (S)	4.39×10^{-3}
Wellfield 1 Test (MW-3)	
Transmissivity (T; ft2/d)	321
Hydraulic Conductivity (k; ft/day)	4.46
Net Sand Thickness (h; ft)	72
Storativity (S)	NA
Wellfield 2 Test (MW-2)	
Transmissivity (T; ft2/d)	711
Hydraulic Conductivity (k; ft/day)	7.33
Net Sand Thickness (h; ft)	97
Storativity (S)	NA

All results are with respect to the Production Zone Aquifer (70 Sand)

No water-level change of significance was observed in the overlying OMW-1 or underlying UMW-1 completions as a result of pumping the PW-1 well completed in the 70 Sand. The UMW-1/OMW-1 wells are located approximately 109 feet from PW-1. No changes of significance were observed in the overlying monitor well during the MW-2 pump test. Well OMW-2 declined slightly during the pumping period, however, the decline continued during recovery. Underlying completions UMW-2 and 1807 (completed in the 68 Sand 252 feet distant) directly responded to pumping, which is expected as the 70 and 68 Sands coalesce in that area.

No significant change in water level was observed in OMW-3 (overlying completion) during the MW-3 pump test. The underlying well (UMW-3) declined steadily during the background monitoring, pumping, and recovery periods (Appendix B1, Figure 5-15). The declining trend in UMW-3 continued through July of 2007, but has since shown a recovering trend. As discussed previously, the cause of the decline is not known; however, long-term monitoring data clearly indicate that the decline was not a result of the MW-3 pump test and has not had an impact on water levels in MW-3.

As previously discussed, the potentiometric surface of the overlying 72 Sand is approximately 50 feet higher than the 70 Sand. This difference in potentiometric surfaces supports the testing data that demonstrate isolation between the 72 and 70 Sands. Hydrographs illustrating the hydraulic relationship between the 70 and 72 Sands are attached (Figures 2.7.2-11a through 2.7.2-11d). Water level data used to develop the hydrographs are included in Table 2.7.2-2. The large difference in heads between the hydrostratigraphic units demonstrates a lack of hydraulic communication between them. Available data indicates the 72 Sand is a perched aquifer system. The uppermost portion of the 70 Sand is unsaturated across much of the site. This unsaturated zone between the 70 Sand and the 72 Sand hydrostratigraphic units provides a buffer that will prevent hydraulic communication between the sands during production and restoration activities. Furthermore, the production and restoration phases of the project will be operated under a net bleed (overpumpage), resulting in declining water levels within the 70 Sand that will further separate the 72 and 70 Sands hydraulically.

The difference in potentiometric surface between the 68 and 70 Sand is variable across the site, indicating a downward gradient in some areas and upward gradient in others. There is very little difference in potentiometric heads in the vicinity of MW-2/UMW-2 where coalescing of the 68 and 70 Sands occurs.

The test results demonstrate that:

- The 70 Sand monitor wells located in the near proximity to the pumping well are in communication, indicating that the 70 Sand production zone has hydraulic continuity. While communication was not exhibited over the entire area, geologic information clearly shows that the 70 Sand is a contiguous sand body across the Moore Ranch Project Area. Additional (mine unit) scale testing required by NRC and WDEQ will demonstrate communication throughout each mine unit between the pumping well(s) and the monitor well ring;

- To adequately stress the 70 Sand, future pump tests may need to incorporate larger-diameter (e.g., 6- or 8-inch) completions to accommodate a 6-inch pump.

- On a regional scale, the 70 Sand has been adequately characterized with respect to hydrogeologic conditions within the test area at the Moore Ranch Project Area;

- Adequate confinement exists between the 70 Sand production zone and the overlying 72 Sand throughout the Moore Ranch Project Area;

- Adequate confinement exists between the 70 Sand production zone and the underlying 68 Sand throughout the northern and western portions of the Moore Ranch Project Area. Where the 68 and 70 Sands coalesce in the center of Section

35, mining operations will be designed to account for this variation in geology and mine-unit scale testing will demonstrate the validity of the recommended approach(s); and,

- Sufficient testing has been conducted to date at Moore Ranch to proceed with a Class III UIC permit application and a NRC license application.

2008 Pump Test Results

EMC did not analyze the data from the Conoco pump tests and only reported the results of the analyses performed by Conoco. The raw data from the Conoco pump tests were unavailable for additional analysis.

EMC conducted three pump tests in 2007 to evaluate aquifer properties of the 70 Sand. The data collected from the 2007 pump tests was suitable for general scoping purposes to determine if ISR methods could be successfully applied at the site. However, the data collected from the 2007 pump tests were not conducive to detailed analysis of aquifer properties because of the limited radius of influence and the strong impacts that barometric changes had on water level data during the tests.

In the test at well PW1, drawdown was observed at observation well MW1 located approximately 109 feet from the pumping well. However, that test was not run under a constant rate, making analysis of the data collected during the test more qualitative than quantitative.

During the MW2 pump test, drawdown was observed at well 1805, completed within the 70 Sand at a distance of 346 feet from the pumping well. That well has been re-analyzed using the Neuman method of analysis that is suitable for delayed yield response typical of unconfined aquifers. Results of the unconfined analysis of 1805 are attached (Figure 2.7.2-12).

The pump test that was performed at well MW3 resulted in no discernible drawdown at any of the monitor locations. The closest 70 Sand monitor well to the pumping well was over 1300 feet away.

EMC recently (2008) conducted a pump test designed to replicate operational conditions for the 70 Sand. A 5-spot pattern was installed within proposed Wellfield 2. The test included a central extraction well, four injectors spaced 100 feet apart, and several additional observation wells at distances of 10, 30, 40 and 70 feet from the extraction well. Boring logs and water level data confirmed that the wells included in the 5 Spot

Pump Test were all within the unconfined portion of the 70 Sand. The initial phase of the test included only pumping from the extraction well. The pumping test was instrumented to allow continuous monitoring during all phases of the test. The data collected from the test was analyzed using a variety of analytical methods including Theis, Cooper-Jacob, Neuman (delayed yield) and Theis recovery. Results of the analyses indicate that the Neuman (delayed yield, unconfined conditions) method provided the best fit to the data. Furthermore, analytical results using the Neuman method were typically only 60 to 70 percent of the value determined using the standard Theis method. Data and analysis from the test are provided in Appendix B2 (Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a)) that is attached. The analytical results reported in that report are considered the most representative of site conditions and provide the basis for additional calculations and modeling pertaining to production and restoration operations. Adjustments to aquifer property data and calculations dependent on those aquifer properties will be made as that data becomes available throughout the project.

Recently acquired field data from a 5 Spot Pump Test provides reliable and representative aquifer characterization of the 70 Sand. Data and analysis from the test are provided in Appendix B2. The results of the pump test were used to construct and validate numerical models that will be used to design future pumps tests that will adequately demonstrate hydraulic communication within the production zone. Results of the modeling indicate that multiple pumping tests will be required to demonstrate hydraulic communication across the production zone. A preliminary simulation of such a pump test and full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

The recently completed 5-Spot Pump Test provided sufficient information to adequately characterize the 70 Sand aquifer system in an area where it is predominately under unconfined conditions. The aquifer characterization data has been incorporated into numerical models that will be used to assist in the design of wellfield development, production and restoration. The 5 Spot Pump Test demonstrated that the aquifer is very responsive to pumping. For example, during the first phase of the 5-Spot Pump Test with pumping occurring at a single extraction well at a rate of 21.7 gpm, drawdown of over 2 feet occurred at all wells within the test area within 1 day. The maximum distance from the pumping wells to the wells on the exterior of the pattern was 71 feet. Using parameters determined from the 5-Spot test (transmissivity of 300 ft2/d, and a specific yield of 0.028), the calculated drawdown at a distance of 500 feet from the pumping well would be approximately 0.5 feet after 10 days of pumping at 22 gpm (Figure 2.7.2-13). The data indicate that a cone of influence could rapidly extended out to a monitor well ring 500 feet from the mined ore zone and that an excursion could be reversed within a relatively short period of time. Additional model simulations will be performed to further refine the methods that would be employed to recover an excursion and to determine the time frame that recovery could be accomplished.

Also, an additional pump test was performed on the historic Conoco well 885 in the summer of 2008. In 1977, Conoco pumped well 885 at a rate of 3.4 gpm for a period of 1 day (a total of 4,900 gallons). During the test, Conoco reported drawdown in an underlying monitoring well (887) of 0.76 feet. The underlying well was reported to be a distance of 119 feet from the pumping well. Conoco stated in its report that the well seal was suspect. Drawdown was also measured at two other 70 Sand monitor wells, 886 and 888, reported to be 64 and 50 ft, respectively from the pumping well. The drawdown in those wells was reported as 0.74 and 1.95 ft, respectively. Note that the well locations reported in the Conoco Permit to Mine Application indicate that the distance from the pumping well to 887, 886 and 885 are actually 159, 161 and 12 feet respectively.

In an attempt to verify the hydraulic communication reported by Conoco, EMC conducted a pump test at well 885 on 6/4/08. Well 885 was pumped at a rate of approximately 15.6 gpm for a period of 20 hours (18,600 gallons). This test provided a significantly larger hydraulic stress to the 70 Sand than the Conoco test. The underlying monitor well (887) showed no response due to pumping of the production zone well (885). There was an unexplained and abrupt shift in the water level at well 887 halfway into the test. However, the shift does not appear to be related to the pumping test because it was a sharp instantaneous rise in water level of 0.1 feet approximately 11 hours into the test. No drawdown was observed during the duration of the test. Drawdown in well 885 was 17.4 feet at the end of the test. Drawdown at 70 Sand monitor well 888 at the end of the test was 2.6 ft. There was no drawdown indicated at location 886 during the test. A map showing the location of the pumping well and monitor wells and plots of the water level data collected during the test are attached. Based on the results of the test, EMC has demonstrated there is no communication between the 70 Sand and 68 Sand in the vicinity of the 885 monitor well. Results of this test can be found in Appendix B3 and the historic testing performed by Conoco can be found in Appendix B5.

2.7.3 Site Baseline Water Quality

Surface Water Quality

As described in Section 2.2.2, water quality data were available from one USGS stream gage (06364700) located on Antelope Creek near Teckla, WY from October 3, 1977 through September 7, 2005. Water quality data analyses revealed a mean temperature of 10.4 degrees Celsius (°C) and a range from 0 to 30 °C. Mean dissolved oxygen was 7.8 milligrams/Liter (mg/L) and ranged from 2.8 to 11.7 mg/L. Total nitrogen averaged 0.55 mg/L and ranged from 0.21 to 1.8 mg/L. Mean ammonia as nitrogen concentrations were 0.04 mg/L and ranged from 0 to 0.13 mg/L. Nitrite plus nitrate as nitrogen averaged 0.04 mg/L, with a range from 0 to 0.29 mg/L. Average phosphate was 0.03 mg/L and average selenium (water filtered) was 0.56 mg/L (USGS 2007). Observed suspended sediment concentrations at the Antelope Creek gage ranged from 5 to greater than 1,000 mg/l for the two-year period of record. The sediment content varies directly with water discharge. Therefore, the bulk of the sediment load is transported during spring snowmelt runoff and spring and summer thunderstorms.

Within the Moore Ranch Project Area, surface water samples were collected from 9 sampling locations at upstream and downstream locations from proposed mining areas during late fall of 2006, early spring of 2007, and late spring of 2007. All locations are existing stock ponds or areas in drainages where ponding occurs. Locations of these sample sites are shown on Figure 2.7.1-1. No surface water was available for sites MRSW-10 and MRSW-11 for sampling during these periods. Water quality data collected from these surface water sites is summarized in Tables 2.7.3-1 through 2.7.3-9, overall average concentrations are shown in Table 2.7.3-11, and seasonal averages are shown in Table 2.7.3-10. Detection limit values were used for non-detectable results for calculation purposes.

In general, surface water contained in the ponds at the sampling locations will exhibit typical saline characteristics of coal-bed methane surface discharge (higher values for conductivity, TDS, and bicarbonate) during summer and fall months. Sampling data shows that surface water quality changes during spring months when dilution occurs from snow melt or heavy precipitation events. Significantly higher values for bicarbonate, carbonate, chloride, conductivity, fluoride, TDS, gross alpha, gross beta, nitrogen, arsenic, potassium, magnesium, and sodium occurred during the fall sampling when the surface water contained was largely comprised of CBM discharge. Values for these parameters were typically the lowest during the samples taken in late March, which were taken soon after a large snowmelt event. Samples taken in June, while showing slightly higher concentrations than the March sampling, were also significantly lower than the fall sample due to the influence of spring runoff water contained in the ponds. Another round of surface water samples will be collected in the third quarter of 2007 (late summer) at locations with available water. It is anticipated that water quality from these samples will resemble results from the samples taken in the fall of 2006.

Average water quality during the fall sampling exceeded Wyoming Class I (domestic use) for TDS, pH, and iron, and just slightly exceeded Class II (agriculture use) and Class III (livestock use) for pH. Averages for the other sampling periods also exceeded all class of use standards for pH. Overall averages for all sample rounds combined also exceed all class of use standards for pH and the Class I standard for TDS. The data tables also show lead average values for the fall and overall averages above the Class I standard, however these values are inaccurately high due to the use of a detection limit of 0.05 mg/L for the fall of 2006 samples in the calculations. This detection limit in itself exceeds the Class I standard of 0.015 mg/L. Sample results for the next two sample rounds show much lower results below the Class I standard. Also, one value for lead-210 activity at MRSW-1 for the fall of 2006 shows an extremely high anomalous value of 170 picocuries per liter (pCi/L), and as a result, was believed to be lab error and excluded from the average calculations.

Groundwater Quality

Information regarding site water quality is primarily derived from studies conducted by Conoco (1982) and from ongoing exploration and delineation of the Moore Ranch Project by EMC. Conoco began a baseline groundwater monitoring program in 1978 as part of its Mine Permit Application for the Sand Rock Project. EMC has initiated a baseline groundwater monitoring program to collect data required for the Permit to Mine and NRC License Applications for the Moore Ranch Uranium Project.

Regional Water Quality

Water quality within the Powder River Basin ranges from very poor to excellent. Groundwater in the near surface, more permeable aquifers is generally of better quality than groundwater in deeper and less permeable aquifers. However, significant regional aquifers are present at depth that can provide relatively good quality water. In particular, the Mesaverde Formation, Frontier Formation, Madison Limestone and Tensleep Sandstone can produce large quantities of acceptable quality water. Overall, water quality tends to degrade moving into the deeper portions of the Powder River Basin.

Sources of water quality data include the historic USGS WATSTOR data system (now replaced by the National Water Information System), the Wyoming Water Resources Research Institute (WWRI) data system (WRDS) and compilations by various authors including Hodson (1971 and 1974), Larson and Daddow (1984), Crawford (1941), Crawford and Davis (1962) and Wells (1979).

Water quality from the Madison Limestone illustrates the downgradient, basinward increase in TDS levels. Springs from Madison outcrops along the west side of the basin generally yield calcium bicarbonate type water containing less than 500 mg/l TDS. Further into the basin, groundwater within the Madison aquifer becomes progressively more saline with TDS values rapidly exceeding 3,000 mg/l. Groundwater transitions to a sodium sulfate, sodium-chloride water type with distance from recharge areas. TDS concentrations rapidly increase in Western Converse County, possibly related to the structural complexity along the north flank of the Laramie Mountains (Feathers 1981).

Similarly, in the western half of the Powder River Basin, water quality from outcrop areas of the Tensleep Formation is generally below 500 mg/l TDS. Low TDS waters tend to be predominately magnesium to calcium-bicarbonate type. Higher TDS samples generally are associated with higher sodium sulfate or sodium chloride levels. (Feathers 1981)

A study conducted by Lowry, et. al. (1986) that included the Powder River Basin as well as upstream parts of the Belle Fourche and Cheyenne River basins, reported that 84 percent of wells and springs reviewed exceeded the USEPA secondary drinking water standard for TDS (500 mg/l) and approximately 55 percent of the samples exceeded 1,000 mg/l. The sample set included 693 wells and springs. The average TDS concentration (in mg/l) reported in the study by formation was as follows.

Table 2.7.3-12 Total Dissolved Concentration by Formation, Powder River Basin (after Lowry et al 1986)

Formation	Average	Min	Max	No of Samples
Alluvium	2,128	106	6,610	38
Wasatch Formation	1,298	227	8,200	191
Fort Union Formation	1,464	209	5,620	257
Fox Hills/Hells Creek Formations	1,100	340	5,450	73
Lance Formation	1,218	251	2,850	31
Tensleep Sandstone*	874	230	6,820	15
Madison Group	1,503	65	3,240	25

* Most of the Tensleep Sandstone samples were collected from springs and near formation outcrop areas

The study noted that the dominant factor affecting TDS concentration within an aquifer is most likely the length of the flow path from recharge to discharge. Wells close to recharge areas generally have the lowest TDS levels and wells farthest from the recharge areas tend to have the highest TDS levels. Only 8 percent of the samples exceeded 3,000 mg/l.

TDS levels within the Fox Hills Sandstone are generally higher in the western side of the basin than the eastern side, ranging between 1,000 and 2,000 mg/l. No water type is prevalent. TDS values from the Lance Formation range from about 200 to more than 2,000 mg/l but are typically between 500 and 1,500 mg/l (Hodson 1973).

Water quality for the Fort Union aquifer is described by Hodson (1973) as having TDS values ranging from 200 to more than 3,000 mg/l, but typically is between 500 and 1,500 mg/l. Water type for the Fort Union is predominately sodium bicarbonate to sodium sulfate.

Within the Wasatch, TDS ranges from less than 200 to more than 8,000 mg/l but typically ranges between 500 and 1500 mg/l. Sodium sulfate and sodium bicarbonate are the dominant water types for the Wasatch aquifer system.

The study by Lowry (1986) indicated that manganese levels exceeded the USEPA secondary drinking water standard (SDWS) of 50 μg/l in 43 percent of the 257 samples reviewed. Iron concentrations exceeded the USEPA SDWS (0.3 mg/l) in over 15 percent of the 366 samples reviewed. Selenium levels exceeded USEPA Maximum Contaminant Level (MCL) of 0.05 mg/l in a small percentage of the wells (2.5 percent). Lead levels exceeded the MCL of 0.015 mg/l in 3.6 percent of the samples. There was no breakdown of the sample groups by formation reported in the study.

Radionuclide data for the Powder River Basin are sparse outside of the uranium mining areas. Feathers and others (1981) reported uranium ranging from 0.5 to over 10,000 μg/l for 96 samples collected from mine monitor wells completed in the Wasatch Formation. Radium-226 samples from the same sample group ranged from 0.2 to 173 pCi/l. Samples from five non-mining locations indicated uranium levels at or below 0.6 μg/l and radium-226 levels at or below 0.8 pCi/l.

Uranium levels from 31 samples from mine monitor wells completed in the Fort Union Formation ranged from 5 to 3,550 μg/l (Feathers 1981). The radium-226 concentration in those same wells ranged from 3.7 to 954 pCi/l. Samples from non-mine wells completed in the Fort Union Formation were generally low in uranium and radium-226 concentration. Samples from Lance and Fox Hills wells were much lower than those completed in the Wasatch and Fort Union mine wells but were similar to the non-mine wells for those formations.

Near Moore Ranch, hydrostratigraphic units deeper than the Fox Hills Sandstone are generally too deep to be economically developed for water supply or have elevated TDS concentrations that render them unusable for consumption. At Moore Ranch, the Lower

Cretaceous and Paleozoic aquifers are separated from the Wasatch aquifer by over 5,000 feet of sediments.

Site Baseline Water Quality

Information regarding site water quality is primarily derived from studies conducted by Conoco (1982) and from ongoing exploration and delineation of the Moore Ranch Project by EMC. Conoco began a baseline groundwater monitoring program in 1978 as part of its Mine Permit Application for the Sand Rock Project. EMC has initiated a baseline groundwater monitoring program to collect data required for the Permit to Mine and NRC License Applications for the Moore Ranch Uranium Project

Groundwater Monitoring Network and Parameters

Conoco installed monitor wells within the proposed License Area that were completed in the production zone aquifer (70 Sand), the overlying aquifer (72 Sand), the underlying aquifer (68 Sand), the 40-50 Sand, and the Roland Coal. The locations of the Conoco monitor wells that were sampled for water quality are shown on Figure 2.7.3.-1. Table 2.7.3-13 provides construction details for the Conoco monitor wells used in the initial baseline analysis for the area. The parameters included in the Conoco Monitoring Program are listed in Table 2.7.3-14.

Based on the data provided in the Conoco Mine Permit Application (1982), many of the wells were only sampled once. However, five of the wells, 1, 8-3, 893, 1808 and 1814, were sampled at least four times from November 1978 through April 1980. Two of the wells that were sampled multiple times by Conoco (1808 and 8-3) and one well (885) that was only sampled once, were also included in recent sampling rounds by EMC. The initial monitoring performed by Conoco, and the continuation of monitoring of some of the original wells, provides an extensive baseline record of water quality that supplements the current baseline sampling program.

Conoco also collected groundwater samples from eleven private wells within and near the proposed License Area. These wells were primarily stock wells. The locations of most of those wells are also shown on Figure 2.7.3-1. Several of the private wells are located over two miles outside the License area and are not shown on the figure. The private wells were sampled for the same parameters as the Conoco monitor wells (Table 2.7.3-14). Construction details on the private wells were generally unavailable. Some of these private wells have also been included in the current EMC baseline sampling program.

EMC has installed a monitor well network to evaluate pre-mining baseline conditions within the License area. Four well groups were constructed, each including a completion in the production zone aquifer, the overlying aquifer, and the underlying aquifer. In addition to the well groups, four new wells completed in the 70 Sand are included in the baseline water quality monitoring network. Three of the original Conoco wells, 8-3, 1808, and 885, and 4 stock wells were also included in the monitoring program. Monitor wells 8-3 and 1808 are completed across both the 70 and 68 Sands. Monitor well 885 is only completed across the 70 Sand. Table 2.7.3-15 provides a summary of well construction information. The locations of wells included in the current monitoring network are shown on Figure 2.7.3-2. The parameters included in the EMC baseline monitoring program are listed in Table 2.7.3-16.

Table 2.7.3-14 Conoco Baseline Water Quality Monitoring Parameters

Major Ions	**Trace Constituents**	**Radionuclides**
Calcium	Aluminum	Radium-226
Magnesium	Ammonia	Uranium
Potassium	Arsenic	Polonium-210
Sodium	Barium	Lead-210
Bicarbonate	Beryllium	Thorium-230
Chloride	Boron	
Carbonate	Cadmium	
Sulfate	Chromium	
Nitrate (Total)	Copper	
	Fluoride	
	Iron	
General Water Chemistry	Lead	
Total Dissolved Solids	Manganese	
pH (field and laboratory measured)	Mercury	
Conductivity(field and lab measured)	Molybdenum	
Temperature (field measured)	Nickel	
	Selenium	
	Vanadium	
	Zinc	

This baseline analysis is intended to evaluate the overall quality of groundwater that is moving beneath the License Area under normal pre-mining conditions and does not provide the final basis for establishing restoration criteria for the individual mine units. The mine unit baseline water quality assessment and restoration goals will be provided to the WDEQ with the Mine Unit Plan and reviewed and approved by the EMC Safety and Environmental Review Panel (SERP).

Two rounds of water sampling have been completed in the newly installed monitor well network as of August 2007. Additional sampling events are planned in order to fully assess seasonal and other potential impacts to groundwater quality. However, as described in following sections, with the exception of a few wells, water quality is generally consistent between the two sampling rounds. Also, data collected from the previous baseline monitoring program conducted by Conoco provide additional information to assess temporal variability in water quality. Current data collected from wells included in the previous baseline monitoring by Conoco show relatively consistent results with the previous data showing consistent water quality for the past 25 years. As a result, EMC does not anticipate any significant changes in water quality for the next two sample rounds and believes that sampling data collected to date is representative of site groundwater quality.

Four stock wells located within the License Area were also sampled by EMC to establish pre-mining groundwater quality. Three of the wells (T-1, P'-9, and P'-11) were previously sampled under the Conoco monitoring program (1978-1980). The locations of the four wells are shown on Figure 2.7.3-2. EMC recently replaced the pumps in those wells and was able to gather the following information.

- Stock Well #1 (formerly referred to as T-1). Pump is set 180' below surface in steel casing. Water right associated with this well is Permit No. 12299. Well may be completed within the 70 Sand based on depth of pump.

- Stock Well #2 (formerly referred to as P'11). Pump is set 260' below surface in steel casing. Well is most likely completed in the 68 Sand.

- Stock Well #3 (formerly referred to as P'9). Pump is set 120' below surface in steel casing. Well is most likely completed in the 70 Sand.

- Stock Well #4 (formerly referred to as P'26). Pump is set 141' below surface in steel casing. Total depth of the well is 158 ft. Water right associated with well is Permit No. 14682. Well is likely completed above the 70 Sand, probably within the 72 sand.

Table 2.7.3-16 EMC Baseline Water Quality Monitoring Parameters

Major Ions	**Trace Constituents**	**Radionuclides**
Calcium	Aluminum (dissolved)	Gross Alpha
Magnesium	Ammonia (as N)	Gross Beta
Potassium (dissolved)	Arsenic (dissolved)	Lead-210 (dissolved and suspended)
Sodium	Barium (dissolved)	Polonium-210 (dissolved and suspended)
Bicarbonate	Beryllium (dissolved)	Radium-226 (dissolved and suspended)
Chloride (dissolved)	Boron	Thorium-230 (dissolved land suspended)
Carbonate	Cadmium (dissolved)	Uranium (dissolved and suspended)
Sulfate	Chromium (dissolved)	
Nitrate + Nitrite (as N)	Copper (dissolved)	
Silica	Fluoride	
	Iron (dissolved and total)	
	Lead (dissolved)	
General Water Chemistry	Manganese (dissolved and total)	
Total Dissolved Solids (@180 F)	Mercury (dissolved)	
pH (field and laboratory measured)	Molybdenum (dissolved)	
Conductivity(field and lab measured)	Nickel (dissolved)	
Temperature (field measured)	Selenium (dissolved)	
	Vanadium	
	Zinc (dissolved)	

Groundwater Quality Sampling Results

Results of the Conoco and EMC baseline monitoring programs are summarized in Tables 2.7.3-17, 2.7.3-18, and 2.7.3-19. Overall water quality determined from the monitoring programs indicates a predominately calcium sulfate to calcium bicarbonate water, although significant differences are apparent between the Production Zone and overlying and underlying aquifers. Figure 2.7.3-3 is a Piper diagram of the average ion concentration for each of the monitor wells included in the EMC baseline sampling program (completed in the 68 through 72 Sands). Groundwater within the production zone aquifer is generally a calcium sulfate type. The overlying monitor wells exhibit a generally calcium sulfate type water with the exception of OMW3, which is a calcium bicarbonate type. The underlying monitor wells are more variable, ranging from calcium-to-sodium-sulfate and calcium-to-sodium-bicarbonate. Chloride and carbonate are generally very low in all of the wells.

Figure 2.7.3-4 is a Piper diagram for the average ion concentration for each of the aquifers (including a category for those wells screened in both the 68 and 70 Sands) for the EMC baseline sampling program. Historic data from the wells completed in the 40-50 Sand and the Roland Coal (wells 1822 and 1821 respectively) are also included on the diagram for reference. The water types for these two deeper aquifers show progressively decreasing sulfate and increasing bicarbonate and sodium with depth. The Roland coal sample is clearly a sodium bicarbonate water type. The typical 68 Sand (underlying aquifer) water type appears more like the 40-50 Sand and Roland Coal type water than the 70 (production zone) and 72 Sands (overlying aquifer). A Stiff diagram of the water quality for the different aquifers shows the transition with depth from a calcium sulfate water to a sodium bicarbonate water (Figure 2.7.3-5)

Three wells that were installed and monitored by Conoco (1982) were included in the current monitoring program. One of the wells, 885, is completed in the production zone aquifer and the other two wells are completed across the production zone and underlying aquifers. Table 2.7.3-20a compares the analytical results of these monitor wells from the Conoco and EMC baseline monitoring programs. The table shows that two of the monitor wells, 885 and 1808 have shown reasonably consistent water quality since the initial sampling began in 1978. Well 8-3 appears to have anomalous values as described below.

The two wells completed across multiple aquifers, 1808 and 8-3, would be expected to have water quality that falls within the range observed in those two sands. That is the case for well 1808 (Figure 2.7.3-3). However, well 8-3 plots outside of the range observed within either the 68 or 70 sand. The calcium, magnesium and sulfate levels in that well are much higher than the values observed in other monitor wells included in the EMC program. Correspondingly, TDS for 8-3 was over twice as high as for any other production zone or underlying monitor well. In addition, the calcium, magnesium and sulfate levels in well 8-3 are much higher in the recent sampling events than when the well was first sampled by Conoco in 1979 (Table 2.7.3-20a). Other parameters show relatively good consistency with other wells and historic data. A potential cause of these anomalous values for calcium, magnesium, and sulfate could be related to impacts from small mammals falling into the well. This well was covered by a box that contained an old strip chart recorder and float for continuous water level measurement, which protected the well from the weather. However, evidence that small mammals had fallen down the well was observed when the old recording equipment was removed for sampling. Decay of the organic material in the well is a possible cause of the anomalous values detected during monitoring. While several casing volumes were removed during sampling, this well will be flushed by air lifting or increased purging prior to the next sampling round. This anomaly will be evaluated further with additional sampling events. Water quality in the other two wells, 885 and 1808, did not change significantly between the historic Conoco and the EMC sampling events.

Table 2.7.3-20b compares the analytical results from the private wells that have been sampled under both the Conoco and EMC baseline monitoring programs. The list of constituents common to both data sets is not as complete as for the monitor wells listed in Table 2.7.3-20a because not all of the parameters were sampled by Conoco. However, the parameters that were monitored show good consistency over time, an indication of the relatively stable long term aquifer conditions in the area. Future baseline monitoring is anticipated to show a continuation of this long term stability.

Table 2.7.3-21 is a summary of the analytical results for the current EMC baseline monitoring for wells completed in the production zone and the overlying and underlying aquifers. Wells that are screened across multiple aquifers or that are of unknown completion intervals are not included in the table. The results are compared to WDEQ Class I Standards and USEPA MCLs.

As shown on the table, over half of the samples exceeded the WDEQ Class I standard for TDS (500 mg/l), with the greatest proportion of exceedences occurring in samples from the production zone aquifer. Figure 2.7.3-6 shows the distribution of TDS in the production zone and the overlying and underlying aquifers. The range of TDS within wells completed in either the production zone or the underlying or overlying aquifers was 266 to 1350 mg/l with an average of 629 mg/l. Well 8-3, which is not included in the table because it is completed across both the production zone and the underlying aquifers, had an average TDS value of 2,380 mg/l over the two recent sampling events.

Similarly, almost half of the production zone samples exceeded the WDEQ Class I standard for sulfate of 250 mg/l (Figure 2.7.3-7). Sulfate ranged from 79 to 743 mg/l with an average of 301.6 mg/l. The highest sulfate value was found in well 8-3 (1,430 mg/l) which, again, was not included in the table because the well is completed across both the production zone and underlying aquifer and due to potential well biological contamination as discussed above.

Ammonia, iron, manganese, and selenium were the only trace minerals to exceed standards. The ammonia WDEQ Class I standard of 0.05 mg/l was exceeded at two overlying monitor wells (OMW1 and OMW2). Iron exceeded the WDEQ Class I standard (0.3 mg/l) in one underlying well (UMW4), one overlying monitor well (OMW4), and two production zone monitor wells (MW11 and PW-1) and at well 8-3.

Iron ranged from below detection to 3.34 mg/l. Manganese exceeded the WDEQ Class I standard (0.05 mg/l) in one production zone monitor well (885) and one overlying monitor well (OMW4). The selenium standard (0.5 mg/l for WDEQ Class I and EPA MCL) was exceeded in two wells in the underlying aquifer (UMW2 and UMW4) and two wells in the production zone aquifer (MW2 and MW7).

The majority of the samples collected from the production zone and underlying aquifers exceeded the USEPA MCLs for uranium (0.03 mg/l) and radium 226+228 (5 pCi/l). None of the samples from the overlying monitor wells exceeded the standard for uranium and only one exceeded the radium standard (OMW3). Figure 2.7.3-8 shows the distribution of uranium within the three aquifers. Uranium ranged from below detection (<0.0003) to 0.864 mg/l. Radium 226 distribution is shown in Figure 2.7.3-9. The average uranium concentration for the production zone aquifer was 0.16 mg/l, over five times the USEPA MCL. For the 68 Sand aquifer, uranium concentration averaged 0.07 mg/l. Radium 226 ranged from below detection (<0.2) to 306 pCi/l with an average of 59.2 pCi/l. Radium-228 values were much lower, ranging from below detection (<1.0) to 9.5 pCi/l. The combined radium 226+228 concentration in the production zone aquifer averaged 96.2 pCi/l, over an order of magnitude greater than the Wyoming Class I Standard or the USEPA MCL.

Underlying wells UMW-1 and UMW-3 had limited water above the J-collar (top of screen liner) available for sampling and the J-collar prevents lowering a pump into the screen. As a result, adequate purging these wells has proven to be difficult and will pose a difficulty in future sampling, which renders the water quality data for these wells questionable and data from wells UMW-4 and UMW-2 are more likely to be representative of water quality in the underlying 68 Sand. EMC will continue sampling efforts in these wells and evaluate any changes in water quality, and water quality of the underlying aquifer will be evaluated extensively during wellfield specific pre-mining baseline hydrologic testing activities.

In summary, general water quality in the shallow Wasatch aquifers within the Moore Ranch License area commonly exceeds WDEQ Class I standards for TDS and SO_4. Radionuclides radium-226 and uranium are elevated above EPA MCLs in the majority of the samples collected from the production zone aquifer and the underlying aquifer. The average radium 226-228 concentration in the production zone is an order of magnitude greater than the USEPA MCL. Elevated concentration of these constituents is consistent with the presence of uranium ore-bodies. Current data collected from wells included in the previous baseline monitoring by Conoco show relatively consistent results with the previous data, showing consistent water quality for the past 25 years (with the exception of the three anomalous values and potential causes for well 8-3 as previously described). As a result, EMC does not anticipate any significant changes in water quality for the next two sample rounds and believes that sampling data collected to date and presented in this application are representative of site groundwater quality, unless otherwise noted.

2.7.3.3 Groundwater Impacts from CBM Discharge

Between 1979 and 1981 Conoco installed 35 piezometers in section 35, T42N, R75W and section 1, T41N, R75W as part of an evaluation of proposed mine tailings and evaporation pond sites. The piezometers were installed in discrete lithologic units (silts, sands, coals and alluvium) contained in the 72 sand aquifer. Two of these piezometers were completed near OMW-2 in sandy sections of the aquifer. The measured water elevations for both wells are similar to the elevations measured currently in the 72 sand. Data from the piezometers and monitor well OMW-2 are presented in Table 2-7.3-22. While saturated thickness levels are below those currently measured in OMW-2, this is likely a relict of completion methods versus quantity of water in the formation. Of the 35 piezometers completed for Conoco's Appendix D-6, only two lacked groundwater. EMC believes the presence of water in the 72 sand in 1979-1980 (some 21 years prior to CBNG development) indicates that the aquifer has been historically present in the area and is not the result of CBNG development. Additionally, Stockwell #4P14682P, located in the SENW quarter of section 26, T42N, R75W and completed in the 72 sand aquifer has been a source of livestock water since the early sixties.

Table 2.7.3-22 Shallow Tailings Area Piezometer Characteristics

Well/Piezometer I.D.	Total Depth	Depth to Water (Ft)	Saturated Thickness (Ft)	Static Water Elevation (Ft. AMSL)	Water Level Date
OMW-2	**78**	**67.62**	**10.38**	**5244.88**	**2/9/2007**
35N-6	**90**	**86.87**	**3.13**	**5236.5**	**5/15/1980**
35N-7C	**84**	**82.09**	**1.91**	**5229.3**	**5/15/1980**

As noted previously in this section, the groundwater within the 72 sands is of the calcium-sulfate type. Shallow groundwater monitoring associated with CBNG water storage facilities in the area also indicates calcium-sulfate type water under baseline conditions (WDEQ-WQD, Sheridan Office, 2008). Groundwater quality data from three monitor wells installed by methane producers in sections 4, 15 and 22 of T42N, R75W, are also of the calcium-sulfate type (MW4-2, MW23-15 and MW22-1). These three wells are under water table conditions and have not received any infiltration from water produced during coal-bed development because they were installed prior to the discharge of CBNG produced water. Based on elevation relationships, it is highly likely that the wells in sections 15 and 22 are installed in the 72 sand aquifer. Similarly, the groundwater encountered in piezometers 35N-6 and 35N-7C (Conoco, 1981) is of the calcium-sulfate type. Both of these piezometers were completed in sandy portions of the 72 sand aquifer.

Shallow aquifer systems which have received CBNG water typically display an evolution from calcium-sulfate to sodium-bicarbonate type (WDEQ-WQD, Sheridan Office, 2008). CBNG water within this area is of the sodium-bicarbonate type. Data from a monitor well (MWAL21-20-1) installed in a shallow alluvial system located in the NENW of section 20, T43N, R77W have been included on the Piper diagrams (Figures 2.7.3-10). These data show the influence from infiltration of CBNG water as sodium and bicarbonate become the dominant ions in the shallow groundwater. The evolution from a calcium-sulfate based water type to sodium-bicarbonate occurred along with a decrease in total dissolved solids. Although groundwater in OMW-3 is somewhat atypical because of the significant presence of the bicarbonate ion, bicarbonate concentrations are far below those observed from nearby CBNG outfalls and the dominant cation remains calcium versus the prevalent sodium from CBNG discharges.

Comparison of the ambient water quality measured in the 72 sand to data from a system being altered by infiltration, indicates that the 72 sand has not received infiltration from nearby discharges. The potential for the water quality of the 72 sand to be impacted by infiltrating CBNG discharges was evaluated through a basic linear velocity analysis using conservative estimates to delineate; 1) minimum travel time for CBNG produced water to infiltrate from the surface through the overlying silts and clays to the top of the sandy portion of the 72 aquifer, and 2) minimum travel time between infiltration into the sandstone (either underlying an impoundment or recharge directly into a sandstone outcrop) to the closest monitoring point. The basic assumptions that were made lead to exceedingly conservative velocities and travel times (see Table 2.7.3-23). Fundamentally, utilizing conservative values for thickness, hydraulic conductivity and porosity it is theoretically possible for the 72 sand to receive water during the lifespan of the Moore Ranch Project. Infiltration into outcrops or subcrops of the 72 sand to where it could potentially reach monitoring locations is less likely, with travel times on the order of tens to hundreds of thousands of years.

Anecdotal evidence provided by the WDEQ-WQD for surface water facilities permitted to receive CBNG produced water provides few instances in which water infiltrating from the facilities has adversely impacted groundwater resources. Groundwater quality has been adversely affected and class of use has changed at only 16 out of 109 permitted impoundments due to infiltration from overlying reservoirs/infiltration pits. Typically, the class of use has changed due to increases in the concentrations of selenium, TDS or sulfate. These data represent nearly four years of data collection from 259 monitor wells installed at sites across the Powder River Basin. Based on the lack of change in groundwater chemistry in the 72 sand aquifer from 1980 to the present, there is no evidence to suggest that this aquifer is impacted.

Table 2.7.3-23 Estimated Linear Travel Times to the 72 Sand Aquifer System

Unit	Thickness (ft)		Thickness (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
Overburden Siltstone	Minimum	30	914	1.0E-04	0.35	1	2.9E-04	0.810	37	0.1
		30	914	1.0E-05	0.35	1	2.9E-05	0.081	370	1.0
		30	914	1.0E-06	0.35	1	2.9E-06	0.008	3704	10.1
	Average	115	3505	1.0E-04	0.35	1	2.9E-04	0.810	142	0.4
		115	3505	1.0E-05	0.35	1	2.9E-05	0.081	1420	3.9
		115	3505	1.0E-06	0.35	1	2.9E-06	0.008	14199	38.9
	Maximum	200	6096	1.0E-04	0.35	1	2.9E-04	0.810	247	0.7
		200	6096	1.0E-05	0.35	1	2.9E-05	0.081	2469	6.8
		200	6096	1.0E-06	0.35	1	2.9E-06	0.008	24694	67.7

Unit	Distance to monitoring point (ft)	Distance (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
72 Sand	9151	2.8E+05	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	2.1E+08	5.7E+05
	851	2.6E+04	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	1.9E+07	5.3E+04

Indicates most conservative travel time and velocity estimate (thinnest overburden, highest K)
Indicates measured variables used in calculations. Values are from Conoco, 1981 and EMC, 2007
Distance is measured from approximate sandstone outcrop on South Fork Ninemile Creek (NESE, S10, T41N, R75W) to monitor well OMW-4
Distance is measured from outfall 020 EPTD to OMW-2 (area where overburden siltstone is thinnest)

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FIGURES (Section 2.7.1)

TABLES (Section 2.7.1)

FIGURES (Section 2.7.2)

TABLES (Section 2.7.2)

FIGURES (Section 2.7.3)

TABLES (Section 2.7.3)

Table 2.7.2-2 Water Level Data, Baseline Monitor Wells, Moore Ranch Uranium Project, Wyoming.

				Measurement Date													
Well ID	Completion Interval	TOC Elev (ft amsl)	Reference	12/22/06	02/08/07	02/09/07	02/14/07	02/19/07	04/26/07	5/1/2007	05/10/07	06/12/07	06/13/07	07/17/07	07/25/07	02/21/08	03/05/08
MW-1	70 Sand		DTW	192.2	191.25	191.95	191.33	192.87	nm	nm	nm	191.4	nm	191.4	193.09	190.83	191.06
		5379.28	WLE	5187.08	5188.03	5187.33	5187.95	5186.41	nm	nm	nm	5187.88	nm	5187.88	5186.19	5188.45	5188.22
MW-2	70 Sand		DTW	124.6	nm	124.26	124.27	123.88	nm	nm	nm	129.4	126	124.3	124.24	123.96	124.18
		5312.40	WLE	5187.80	nm	5188.14	5188.13	5188.52	nm	nm	nm	5183.00	5186.40	5188.10	5188.16	5188.44	5188.22
MW-3	70 Sand		DTW	250.3	250.4	250.55	250.5	250.18	nm	nm	nm	250.6	255	251	250.42	250.2	250.41
		5428.19	WLE	5177.89	5177.79	5177.64	5177.69	5178.01	nm	nm	nm	5177.59	5173.19	5177.19	5177.77	5177.99	5177.78
MW-4	70 Sand		DTW	nm	nm	116.1	116.05	115.68	nm	116	nm	116	115.7	116	116.03	115.78	115.98
		5312.59	WLE	nm	nm	5196.49	5196.54	5196.91	nm	5196.59	nm	5196.59	5196.89	5196.59	5196.56	5196.81	5196.61
MW-5	70 Sand		DTW	135.6	nm	135.59	135.55	135.23	nm	nm	nm	135.6	nm	135.5	135.42	135.14	135.34
		5328.85	WLE	5193.25	nm	5193.26	5193.30	5193.62	nm	nm	nm	5193.25	nm	5193.35	5193.43	5193.71	5193.51
MW-6	70 Sand		DTW	168.9	nm	169.02	168.95	168.6	169.8	nm	nm	169	nm	169	168.94	168.53	168.75
		5352.34	WLE	5183.44	nm	5183.32	5183.39	5183.74	5182.54	nm	nm	5183.34	nm	5183.34	5183.40	5183.81	5183.59
MW-7	70 Sand		DTW	nm	nm	118.67	118.61	118.25	118.9	nm	nm	118.6	nm	118.2	118.52	118.3	118.5
		5311.73	WLE	nm	nm	5193.06	5193.12	5193.48	5192.83	nm	nm	5193.13	nm	5193.53	5193.21	5193.43	5193.23
MW-8	70 Sand		DTW	149.3	nm	149.44	149.4	149.05	nm	nm	nm	nm	nm	168	167.9	148.98	149.2
		5336.06	WLE	5186.76	nm	5186.62	5186.66	5187.01	nm	nm	nm	nm	nm	5168.06	5168.16	5187.08	5186.86
MW-9	70 Sand		DTW	184.4	nm	184.94	184.94	184.58	nm	185	nm	185	nm	185	184.85	184.68	184.89
		5366.78	WLE	5182.38	nm	5181.84	5181.84	5182.20	nm	5181.78	nm	5181.78	nm	5181.78	5181.93	5182.10	5181.89
MW-10	70 Sand		DTW	185.1	nm	185.21	185.34	184.93	nm	nm	nm	185.4	nm	185.2	185.14	184.74	184.95
		5367.28	WLE	5182.18	nm	5182.07	5181.94	5182.35	nm	nm	nm	5181.88	nm	5182.08	5182.14	5182.54	5182.33
MW-11	70 Sand		DTW	242.1	nm	242.28	242.21	241.32	nm	242.2	nm	242.4	nm	242.6	242.55	242.45	242.68
		5414.43	WLE	5172.33	nm	5172.15	5172.22	5173.11	nm	5172.23	nm	5172.03	nm	5171.83	5171.88	5171.98	5171.75
OMW-1	72 Sand		DTW	nm	140.9	141.09	141.05	nm	141	nm	nm	141.2	141.2	141.2	141.24	141.21	141.37
		5379.79	WLE	nm	5238.89	5238.70	5238.74	nm	5238.79	nm	nm	5238.59	5238.59	5238.59	5238.55	5238.58	5238.42
OMW-2	72 Sand		DTW	66.3	nm	67.44	67.35	nm	nm	67.4	75.6	69.6	nm	71.6	70.19	67.72	67.75
		5312.32	WLE	5246.02	nm	5244.88	5244.97	nm	nm	5244.92	5236.72	5242.72	nm	5240.72	5242.13	5244.60	5244.57
OMW-3	72 Sand		DTW	188.1	188.29	188.35	188.34	188.13	187.1	nm	nm	188.6	188	188.5	188.45	188.61	188.73
		5427.72	WLE	5239.62	5239.43	5239.37	5239.38	5239.59	5240.62	nm	nm	5239.12	5239.72	5239.22	5239.27	5239.11	5238.99
OMW-4	72 Sand		DTW	nm	nm	66.11	66.1	nm	66.4	nm	nm	66.4	65	66.6	66.44	66.51	66.65
		5312.41	WLE	nm	nm	5246.30	5246.31	nm	5246.01	nm	nm	5246.01	5247.41	5245.81	5245.97	5245.90	5245.76
UMW-1	68 Sand		DTW	nm	193.52	193.5	193.58	nm	nm	nm	191.4	193.1	nm	193.2	191.22	192.58	192.64
		5379.39	WLE	nm	5185.87	5185.89	5185.81	nm	nm	nm	5187.99	5186.29	nm	5186.19	5188.17	5186.81	5186.75
UMW-2	68 Sand		DTW	125.6	nm	125.55	125.48	nm	nm	nm	nm	125.6	135	125.5	125.41	125.13	125.29
		5313.07	WLE	5187.47	nm	5187.52	5187.59	nm	nm	nm	nm	5187.47	5178.07	5187.57	5187.66	5187.94	5187.78
UMW-3	68 Sand		DTW	109.1	239.35	239.85	241.67	243.35	nm	nm	nm	259.6	nm	267	267.65	249.68	250.12
		5426.89	WLE	5317.79	5187.54	5187.04	5185.22	5183.54	nm	nm	nm	5167.29	nm	5159.89	5159.24	5177.21	5176.77
UMW-4	68 Sand		DTW	123.7	nm	122.18	126.06	nm	nm	nm	125.7	125.9	126	126	125.72	125.28	125.47
		5313.37	WLE	5189.67	nm	5191.19	5187.31	nm	nm	nm	5187.67	5187.47	5187.37	5187.37	5187.65	5188.09	5187.90

Additional measurements for UMW-3				08/17/07	09/04/07	09/25/07	10/01/07	10/03/07	11/20/07
UMW-3	68 Sand		DTW	257.88	254.7	252.4	246.45	319.58	265
		5426.89	WLE	5169.01	5172.19	5174.49	5180.44	5107.31	5161.89

nm - not measured DTW - Depth to water (feet from TOC)
TOC - top of casing WLE - Water level elevation (feet above mean sea level)

			Major Cations and Anions											General Chemistry		
			Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3+NO2 as N	F	Si	TDS @180 F	Conduct.	pH.
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(umhos/cm)	(s.u.)
MR-UMW-1	68	5/11/2007	85	26	76	1	2	4	67	169	0.4	0.3	6.3	538	1620	11.40
MR-UMW-1	68	6/20/2007	88	25	51	1	4	1	16	176	0.3	0.3	7	438	1130	11.50
MR-UMW-1	68	9/26/2007	74	17	18	2	1	13	25	161	0.3	0.2	9.2	318	620	10.70
MR-UMW-2	68	5/11/2007	50	17	73	6	2	214	3	168	0.4	0.2	8.9	448	674	8.31
MR-UMW-2	68	6/18/2007	50	17	32	1	2	<1	4	133	<0.1	0.3	12.2	266	552	11.00
MR-UMW-2	68	9/26/2007	47	14	9	1	<1	30	15	102	0.2	0.1	8.9	240	316	9.69
MR-UMW-2	68	11/13/2007	46	13	37	2	<1	130	9	96	0.1	0.1	9.3	259	444	9.00
MR-UMW-3	68	3/22/2007	37	9	109	27	2	265	<1	245	<0.1	0.2	12.8	540	851	7.81
MR-UMW-3	68	6/20/2007	76	39	44	<0.5	7	<1	<1	208	<0.1	0.2	5.3	440	1000	11.40
MR-UMW-3	68	10/3/2007	34	15	97	23	2	269	<1	226	<0.1	0.2	13.7	570	872	7.40
MR-UMW-4	68	5/9/2007	76	12	66	8	2	231	<1	212	0.8	0.3	10.7	528	794	7.81
MR-UMW-4	68	6/15/2007	72	10	56	8	5	246	<1	161	0.6	0.3	11.9	448	710	7.96
MR-UMW-4	68	6/19/2007	81	11	41	8	<1	210	<1	144	0.6	0.3	17.3	400	633	8.09
MR-UMW-4	68	9/27/2007	76	10	53	9	1	232	<1	149	0.3	0.2	14.4	428	665	7.50
MR-UMW-4	68	11/20/2007	72	10	44	7	2	235	<1	126	0.3	0.2	13.6	410	665	7.65
MR-MW-2	70	3/21/2007	18	9	133	30	3	297	<1	226	0.2	0.2	13.2	582	860	7.61
MR-MW-2	70	6/19/2007	24	10	177	38	5	290	<1	450	<0.1	0.2	13.8	906	1220	7.41
MR-MW-2	70	9/26/2007	25	10	189	42	5	302	<1	478	<0.1	0.1	14.4	928	1290	7.49
MR-MW-2	70	11/13/2007	24	9	185	40	5	301	<1	437	<0.1	0.1	13.1	890	1240	7.64
MR-MW-3	70	3/22/2007	37	9	109	27	2	265	<1	245	<0.1	0.2	12.8	540	844	7.59
MR-MW-3	70	6/20/2007	37	14	103	26	4	261	<1	249	<0.1	0.2	12.9	562	878	7.73
MR-MW-3	70	10/3/2007	34	16	96	23	2	267	<1	222	<0.1	0.2	13.6	574	870	7.56
MR-MW-3	70	11/1/2007	36	15	92	23	2	271	<1	198	<0.1	0.1	12.4	540	873	7.62
MR-MW-4	70	4/30/2007	41	15	175	48	3	256	<1	568	1.5	0.1	9.9	968	1335	7.60
MR-MW-4	70	6/13/2007	37	14	194	56	4	256	<1	600	<0.1	0.1	12.1	1090	1450	7.63
MR-MW-4	70	9/27/2007	32	13	236	64	1	307	<1	665	<0.1	0.1	15.3	1200	1590	7.47
MR-MW-4	70	11/20/2007	28	12	203	53	4	303	<1	566	<0.1	0.1	12.8	1190	1560	7.35
MR-MW-6	70	4/26/2007	18	9	91	18	1	244	<1	164	0.8	0.2	11.6	452	705	7.50
MR-MW-6	70	6/12/2007	19	9	94	20	<1	244	<1	170	0.1	0.2	12.4	440	715	7.70
MR-MW-6	70	9/25/2007	16	8	101	21	<1	265	<1	169	<0.1	0.1	12.8	442	698	7.55
MR-MW-6	70	11/12/2007	13	8	95	20	<1	287	<1	143	<0.1	0.1	12.1	435	741	7.45
MR-MW-7	70	4/26/2007	26	7	73	15	1	159	<1	187	0.5	0.4	14.2	420	659	7.70
MR-MW-7	70	6/12/2007	24	7	72	16	<1	213	<1	121	0.3	0.2	13.2	352	590	7.76
MR-MW-7	70	9/25/2007	16	7	72	16	<1	247	<1	85	<0.1	0.2	12.7	320	514	7.74
MR-MW-7	70	11/12/2007	14	6	67	14	<1	257	<1	76	0.2	0.2	10.7	298	549	7.52
MR-MW-9	70	5/1/2007	55	11	100	21	2	239	<1	283	0.2	0.2	11.6	650	970	8.10
MR-MW-9	70	6/12/2007	62	12	104	25	1	237	<1	312	0.2	0.2	12.4	638	975	8.10
MR-MW-9	70	9/25/2007	54	11	114	28	<1	270	<1	320	<0.1	0.1	14.8	662	998	7.94
MR-MW-9	70	11/15/2007	52	10	121	30	<1	285	<1	306	<0.1	0.1	13.2	706	1020	7.87
MR-MW-11	70	5/4/2007	54	10	160	38	2	305	<1	460	0.1	0.2	13.2	880	1223	7.13
MR-MW-11	70	6/20/2007	53	11	163	37	2	305	<1	458	<0.1	0.2	14.3	890	1250	7.36
MR-MW-11	70	10/1/2007	48	10	174	42	2	315	<1	460	<0.1	0.1	14.3	906	1310	7.36
MR-MW-11	70	11/1/2007	47	10	155	37	2	317	<1	373	<0.1	0.1	14.2	885	1270	7.34
MR-PW-1	70	2/16/2007	22	9	156	37	2	293	<1	363	<0.1	0.1	13.6	754	1066	7.45
MR-PW-1	70	6/18/2007	89	24	38	<1	3	<1	8	169	0.3	0.3	7.6	420	975	11.50
MR-PW-1	70	10/2/2007	21	11	141	32	3	310	<1	296	<0.1	0.1	14.5	750	1080	7.43
MR-PW-1	70	11/15/2007	24	11	152	35	3	310	<1	342	<0.1	0.1	14	748	1060	7.69
MR-885	70	5/2/2007	40	9	155	34	3	300	<1	370	0.3	0.2	12.2	842	1203	7.17
MR-885	70	6/15/2007	37	8	154	35	3	300	<1	407	<0.1	0.2	11.6	802	1150	7.55
MR-885	70	10/2/2007	38	10	158	35	3	312	<1	375	<0.1	0.1	12.7	844	1230	7.40
MR-885	70	11/15/2007	39	9	168	38	3	312	<1	416	<0.1	0.1	11.8	850	1210	7.64

			Major Cations and Anions											General Chemistry		
			Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3+NO2 as N	F	Si	TDS @180 F	Conduct.	pH.
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(umhos/cm)	(s.u.)
MR-1808	68-70	5/3/2007	60	8	104	20	3	179	<1	316	0.1	0.3	6.6	602	976	8.10
MR-1808	68-70	6/19/2007	64	7	97	19	3	178	<1	322	<0.1	0.3	9.4	638	916	7.38
MR-1808	68-70	10/1/2007	62	7	104	21	3	184	<1	325	<0.1	0.2	9	584	915	7.82
MR-1808	68-70	11/12/2007	59	7	94	19	3	185	<1	286	<0.1	0.2	8.6	570	903	7.66
MR-8-3	68-70	5/2/2007	15	12	399	149	<1	370	<1	1410	0.2	0.1	12.8	2270	2740	6.93
MR-8-3	68-70	6/13/2007	9	12	408	176	2	359	<1	1430	<0.1	<0.1	12.8	2380	2660	7.13
MR-8-3	68-70	9/27/2007	9	13	427	185	1	377	<1	1440	<0.1	<0.1	13.6	2310	2610	7.21
MR-8-3	68-70	11/15/2007	9	13	374	146	2	430	<1	1360	<0.1	<0.1	12.2	2240	2540	7.51
MR-OMW-1	72	4/27/2007	26	21	88	14	3	191	2	191	<0.2	0.2	11.8	454	713	8.85
MR-OMW-1	72	6/18/2007	30	26	53	9	5	84	4	189	<0.1	0.2	11.7	348	566	8.99
MR-OMW-1	72	9/26/2007	23	25	90	14	5	180	<1	195	<0.1	<0.1	12.8	464	685	8.41
MR-OMW-1	72	11/15/2007	16	22	100	20	4	247	<1	189	<0.1	<0.1	12.8	483	753	8.10
MR-OMW-2	72	5/10/2007	55	10	129	21	4	45	7	466	0.2	0.2	3.4	818	847	9.20
MR-OMW-2	72	6/12/2007	72	12	172	34	6	74	<1	667	0.2	0.2	4	1050	1400	8.43
MR-OMW-2	72	9/27/2007	73	12	198	42	7	99	<1	719	<0.1	0.2	5.3	1100	1500	8.04
MR-OMW-2	72	11/13/2007	73	11	193	41	8	111	<1	695	<0.1	0.2	5.3	1080	1460	8.03
MR-OMW-3	72	4/26/2007	32	15	58	11	2	229	<1	108	0.4	0.2	11	348	571	7.97
MR-OMW-3	72	6/14/2007	19	15	59	18	4	239	<1	79	<0.1	0.2	14.2	314	527	8.12
MR-OMW-3	72	9/25/2007	15	12	69	20	<1	275	<1	75	<0.1	<0.1	16.1	310	539	7.95
MR-OMW-3	72	11/1/2007	14	11	62	17	1	263	<1	65	<0.1	<0.1	13.8	311	558	7.80
MR-OMW-4	72	4/30/2007	19	16	229	84	4	327	<1	743	3.7	0.2	13.4	1320	1656	7.30
MR-OMW-4	72	6/13/2007	19	20	250	79	3	310	<1	722	<0.1	<0.1	12.8	1350	1700	7.30
MR-OMW-4	72	9/27/2007	17	20	250	89	4	324	<1	695	<0.1	<0.1	13.2	1290	1690	7.38
MR-OMW-4	72	11/20/2007	14	17	198	84	5	333	<1	618	<0.1	<0.1	12.5	1290	1660	7.18
Stockwell #1	70?	4/27/2007	53	8	149	33	2	273	<1	404	0.4	0.2	11	806	1179	7.50
Stockwell #1	70?	6/13/2007	59	9	149	34	2	273	<1	410	0.2	0.2	11.3	822	1180	7.51
Stockwell #1	70?	10/1/2007	22	10	281	79	5	358	<1	798	<0.1	<0.1	14.1	1390	1870	7.32
Stockwell #1	70?	11/20/2007	20	10	244	70	9	355	<1	668	<0.1	0.1	12.6	1400	1770	7.26
Stockwell #2	68?	4/27/2007	22	10	286	78	8	346	<1	776	0.2	0.2	13.8	1420	1748	7.10
Stockwell #2	68?	6/13/2007	24	10	268	80	9	344	<1	769	<0.1	0.1	14.1	1450	1800	7.34
Stockwell #2	68?	10/1/2007	54	9	153	34	2	282	<1	421	0.2	0.1	11.2	792	1190	7.57
Stockwell #2	68?	11/20/2007	52	9	135	28	2	276	<1	350	0.3	0.2	9.9	798	1150	7.37
Stockwell #3	70?	4/27/2007	29	11	456	166	6	388	<1	1500	0.3	0.2	9.2	2470	2980	7.25
Stockwell #3	70?	6/13/2007	30	11	455	168	6	403	<1	1530	<0.1	0.2	9	2550	2860	7.32
Stockwell #3	70?	10/1/2007	30	11	419	144	5	394	<1	1360	<0.1	0.1	10.2	2180	2620	7.32
Stockwell #3	70?	11/20/2007	25	11	377	129	7	397	<1	1220	<0.1	0.2	9	2350	2620	6.96
Stockwell #4	72?	5/9/2007	3	3	64	24	6	232	<1	75	2.5	0.4	9.1	340	524	7.50
Stockwell #4	72?	6/19/2007	4	3	69	25	5	234	<1	79	2.2	0.6	10.1	358	544	7.42
Stockwell #4	72?	10/1/2007	3	3	72	27	6	239	<1	79	2.2	0.4	9.7	302	503	7.75
Stockwell #4	72?	11/20/2007	3	3	64	23	7	245	<1	63	2.9	0.4	9.1	321	560	7.58

NOTE STOCKWELL #1 and #2 appear to have been switched going from the 1st and 2nd sampling round to the 3rd and fourth round

< - indicates sample was below reporting limit

tot. - total dis.-dissolved sus.- suspended

Table 2.7.3-19 Analytical Results EMC Baseline Monitoring Program

			Trace Metals																
			Al	NH4 as N	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	V	Zn
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
MR-UMW-1	68	5/11/2007	<0.1	3.11	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	0.005	<0.01	<0.001	<0.1	<0.05	0.016	<0.1	<0.01
MR-UMW-1	68	6/20/2007	<0.1	1.96	0.004	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	0.013	<0.01	<0.001	<0.1	<0.05	0.022	<0.1	<0.01
MR-UMW-1	68	9/26/2007	<0.1	0.53	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.029	<0.1	<0.01
MR-UMW-2	68	5/11/2007	<0.1	0.10	0.006	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.402	<0.1	<0.01
MR-UMW-2	68	6/18/2007	<0.1	0.21	0.003	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.370	<0.1	0.01
MR-UMW-2	68	9/26/2007	<0.1	0.18	0.003	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.341	<0.1	<0.01
MR-UMW-2	68	11/13/2007	<0.1	0.07	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.458	<0.1	<0.01
MR-UMW-3	68	3/22/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-UMW-3	68	6/20/2007	<0.1	0.26	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	0.009	<0.01	<0.001	<0.1	<0.05	0.007	<0.1	<0.01
MR-UMW-3	68	10/3/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.06	0.027	<0.01	<0.001	<0.1	<0.05	0.004	<0.1	<0.01
MR-UMW-4	68	5/9/2007	<0.1	0.05	0.003	<0.1	<0.1	<0.005	<0.05	0.03	0.31	0.018	0.03	<0.001	<0.1	<0.05	0.052	<0.1	0.01
MR-UMW-4	68	6/15/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.069	<0.1	0.01
MR-UMW-4	68	6/19/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	0.002	0.01	<0.001	<0.1	<0.05	0.060	<0.1	0.01
MR-UMW-4	68	9/27/2007	<0.1	0.08	0.003	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.037	<0.1	<0.01
MR-UMW-4	68	11/20/2007	<0.1	0.07	0.003	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.027	<0.1	<0.01
MR-MW-2	70	3/21/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.527	<0.1	0.01
MR-MW-2	70	6/19/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.05	<0.001	<0.1	<0.05	0.004	<0.1	<0.01
MR-MW-2	70	9/26/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.05	<0.001	0.05	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
MR-MW-2	70	11/13/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.05	<0.001	0.05	<0.001	<0.1	<0.05	0.004	<0.1	<0.01
MR-MW-3	70	3/22/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-3	70	6/20/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-3	70	10/3/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.05	0.032	<0.01	<0.001	<0.1	<0.05	0.004	<0.1	<0.01
MR-MW-3	70	11/1/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-4	70	4/30/2007	<0.1	0.13	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-4	70	6/13/2007	<0.1	0.11	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-4	70	9/27/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.35	<0.001	0.05	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-4	70	11/20/2007	<0.1	0.06	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.2	<0.001	0.06	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-6	70	4/26/2007	<0.1	0.06	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.006	<0.1	<0.01
MR-MW-6	70	6/12/2007	<0.1	<1.0	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.004	<0.1	<0.01
MR-MW-6	70	9/25/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
MR-MW-6	70	11/12/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.003	<0.1	<0.01
MR-MW-7	70	4/26/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.045	<0.1	<0.01
MR-MW-7	70	6/12/2007	<0.1	<0.05	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.119	<0.1	<0.01
MR-MW-7	70	9/25/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.024	<0.1	<0.01
MR-MW-7	70	11/12/2007	<0.1	<0.05	0.004	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.113	<0.1	<0.01
MR-MW-9	70	5/1/2007	<0.1	0.20	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-9	70	6/12/2007	<0.1	0.20	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	0.04	<0.001	0.02	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-MW-9	70	9/25/2007	<0.1	0.14	0.004	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-9	70	11/15/2007	<0.1	0.09	0.005	<0.1	<0.1	<0.005	<0.05	<0.01	0.14	<0.001	0.02	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-11	70	5/4/2007	<0.1	0.10	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.47	<0.001	0.03	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-11	70	6/20/2007	<0.1	0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	0.6	<0.001	0.04	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-MW-11	70	10/1/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.43	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-MW-11	70	11/1/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	0.33	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-PW-1	70	2/16/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.85	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	0.02
MR-PW-1	70	6/18/2007	<0.1	2.01	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	0.011	<0.01	<0.001	<0.1	<0.05	0.023	<0.1	<0.01
MR-PW-1	70	10/2/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.33	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-PW-1	70	11/15/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.47	<0.001	0.04	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-885	70	5/2/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.15	<0.001	0.05	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-885	70	6/15/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
MR-885	70	10/2/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.11	<0.001	0.05	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-885	70	11/15/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.14	<0.001	0.05	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01

			Trace Metals																
			Al	NH4 as N	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	V	Zn
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
MR-1808	68-70	5/3/2007	<0.1	0.06	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.003	<0.1	<0.01
MR-1808	68-70	6/19/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-1808	68-70	10/1/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-1808	68-70	11/12/2007	<0.1	<0.05	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.05	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-8-3	68-70	5/2/2007	<0.1	1.62	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	3.34	<0.001	0.53	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-8-3	68-70	6/13/2007	<0.1	0.24	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	1.08	<0.001	0.52	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-8-3	68-70	9/27/2007	<0.1	2.72	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	2.66	<0.001	0.52	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
MR-8-3	68-70	11/15/2007	<0.1	13.20	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	2.35	<0.001	0.49	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-1	72	4/27/2007	<0.1	0.53	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-1	72	6/18/2007	<0.1	0.59	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-1	72	9/26/2007	<0.1	0.30	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-1	72	11/15/2007	<0.1	0.19	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.05	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	0.02
MR-OMW-2	72	5/10/2007	<0.1	0.33	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	0.003	<0.1	<0.01
MR-OMW-2	72	6/12/2007	<0.1	<1.0	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.003	<0.1	<0.01
MR-OMW-2	72	9/27/2007	<0.1	0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.09	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-2	72	11/13/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-3	72	4/26/2007	<0.1	0.23	0.003	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-3	72	6/14/2007	<0.1	0.22	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-3	72	9/25/2007	<0.1	0.15	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-3	72	11/1/2007	<0.1	0.08	0.002	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	<0.01	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-4	72	4/30/2007	<0.1	0.16	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.41	<0.001	0.22	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
MR-OMW-4	72	6/13/2007	<0.1	0.16	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.17	<0.001	<0.1	<0.05	<0.001	<0.1	0.01
MR-OMW-4	72	9/27/2007	<0.1	0.17	0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.46	<0.001	0.18	<0.001	<0.1	<0.05	<0.001	<0.1	0.01
MR-OMW-4	72	11/20/2007	<0.1	0.16	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.2	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #1	70?	4/27/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	0.010	<0.1	<0.01
Stockwell #1	70?	6/13/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.05	<0.001	<0.1	<0.05	0.012	<0.1	<0.01
Stockwell #1	70?	10/1/2007	<0.1	0.06	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	2.05	<0.001	0.25	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
Stockwell #1	70?	11/20/2007	<0.1	0.07	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.89	<0.001	0.25	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #2	68?	4/27/2007	<0.1	0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.03	<0.001	0.24	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #2	68?	6/13/2007	<0.1	0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.58	<0.001	0.25	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #2	68?	10/1/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.07	<0.001	<0.1	<0.05	0.012	<0.1	<0.01
Stockwell #2	68?	11/20/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	0.009	<0.1	<0.01
Stockwell #3	70?	4/27/2007	<0.1	0.10	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	4.86	<0.001	0.46	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #3	70?	6/13/2007	<0.1	0.14	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.24	<0.001	0.46	<0.001	<0.1	<0.05	0.001	<0.1	<0.01
Stockwell #3	70?	10/1/2007	<0.1	0.10	<0.001	<0.1	<0.1	<0.005	<0.05	0.01	3.48	<0.001	0.37	<0.001	<0.1	<0.05	0.003	<0.1	<0.01
Stockwell #3	70?	11/20/2007	<0.1	0.15	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	3.11	<0.001	0.42	<0.001	<0.1	<0.05	<0.001	<0.1	<0.01
Stockwell #4	72?	5/9/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	0.13	0.004	0.04	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
Stockwell #4	72?	6/19/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.06	<0.001	<0.1	<0.05	0.002	<0.1	0.02
Stockwell #4	72?	10/1/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.03	<0.001	<0.1	<0.05	0.002	<0.1	<0.01
Stockwell #4	72?	11/20/2007	<0.1	<0.05	<0.001	<0.1	<0.1	<0.005	<0.05	<0.01	<0.03	<0.001	0.02	<0.001	<0.1	<0.05	0.001	<0.1	<0.01

NOTE STOCKWELL #1 and #2 appear to have been switched going from the 1st and 2nd sampling round to the 3rd and fourth round

< - indicates sample was below reporting limit

tot. - total dis.-dissolved sus.- suspended

					Radionuclides												
			Fe (tot.)	Mn (tot.)	G Alpha	G Beta	Pb-210 (dis.)	Po-210 (dis.)	Ra-226 (dis.)	Ra-228 (dis.)	Th-230 (dis.)	U (dis.)	Pb-210 (sus.)	Po-210 (sus.)	Ra-226 (sus.)	Th-230 (sus.)	U (sus.)
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(mg/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(mg/l)
MR-UMW-1	68	5/11/2007	<0.03	<0.01	13.3	25	<1.0	<1.0	0.8	<1.0	<0.2	0.0095	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-1	68	6/20/2007	0.15	0.01	NM	NM	<1.0	<1.0	5.4	<1.0	<0.2	0.0039	<1.0	2.1	<0.2	<0.2	<0.0003
MR-UMW-1	68	9/26/2007	<0.03	<0.01	4.8	12.8	<1.0	<1.0	0.7	<1.0	<0.2	0.007	2.7	<1.0	<0.2	0.3	0.0038
MR-UMW-2	68	5/11/2007	<0.03	<0.01	83.3	36.8	<1.0	1.8	1	<1.0	<0.2	0.112	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-2	68	6/18/2007	<0.03	<0.01	NM	NM	<1.0	<1.0	0.6	<1.0	<0.2	0.0188	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-2	68	9/26/2007	<0.03	<0.01	NM	NM	<1.0	<1.0	<0.2	<1.0	<0.2	0.0454	<1.0	15.0	40.6	43.7	0.236
MR-UMW-2	68	11/13/2007	<0.03	<0.01	49.7	18.6	2.4	2.3	1	<1.0	<0.2	0.0824	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-3	68	3/22/2007	0.13	0.02	370	162	69	34	280	<1.0	<0.2	0.0837	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-3	68	6/20/2007	0.51	0.02	NM	NM	<1.0	<1.0	14.9	<1.0	<0.2	<0.0003	18.0	23.0	2.7	<0.2	<0.0003
MR-UMW-3	68	10/3/2007	0.15	0.02	3.4	24.1	<1.0	<1.0	1.4	<1.0	<0.2	<0.0003	15.0	23.0	1.0	0.3	0.0107
MR-UMW-4	68	5/9/2007	0.04	0.02	53.4	18.4	<1.0	<1.0	1	3.3	<0.2	0.0685	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-4	68	6/15/2007	0.12	0.02	NM	NM	<1.0	<1.0	0.6	<1.0	<0.2	0.0747	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-UMW-4	68	6/19/2007	0.10	0.01	NM	NM	<1.0	<1.0	0.9	<1.0	<0.2	0.0688	<1.0	<1.0	<0.2	0.2	<0.0003
MR-UMW-4	68	9/27/2007	0.03	0.03	NM	NM	<1.0	<1.0	0.8	<1.0	<0.2	0.0656	<1.0	<1.0	1.2	<0.2	0.0008
MR-UMW-4	68	11/20/2007	<0.03	0.03	48	23	13	1.6	1.4	<1.0	<0.2	0.0618	<1.0	2.3	<0.2	0.4	<0.0003
MR-MW-2	70	3/21/2007	<0.03	0.03	1050	327	31	51	138	<1.0	<0.2	0.739	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-2	70	6/19/2007	0.05	0.05	NM	NM	11	2.8	220	3.8	<0.2	0.884	<1.0	3.3	<0.2	<0.2	<0.0003
MR-MW-2	70	9/26/2007	0.06	0.05	NM	NM	<1.0	<1.0	206	2.9	0.6	0.859	38.0	19.0	4.8	7.3	0.0519
MR-MW-2	70	11/13/2007	0.06	0.05	874	197	13	3.9	302	3.4	<0.2	0.847	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-3	70	3/22/2007	0.13	0.02	370	162	69	34	280	<1.0	<0.2	0.0837	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-3	70	6/20/2007	0.14	0.02	NM	NM	21	7.3	242	5.9	0.6	0.144	41.0	15.0	8.1	<0.2	<0.0003
MR-MW-3	70	10/3/2007	0.15	0.02	3.5	22.8	<1.0	<1.0	1.4	<1.0	<0.2	<0.0003	18.0	18.0	1.2	<0.2	0.0097
MR-MW-3	70	11/1/2007	0.17	0.02	445	129	25	9.9	335	<1.0	<0.2	0.0933	7.8	8.3	2.8	<0.2	0.0007
MR-MW-4	70	4/30/2007	2.04	0.03	201	53.8	<1.0	<1.0	45.7	1.7	<0.2	0.13	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-4	70	6/13/2007	0.56	0.04	NM	NM	<1.0	<1.0	42	<1.0	<0.2	0.0895	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-4	70	9/27/2007	0.78	0.05	NM	NM	<1.0	<1.0	31.9	1.7	<0.2	0.0607	<1.0	<1.0	3.3	<0.2	0.0006
MR-MW-4	70	11/20/2007	0.88	0.06	83.4	39.4	7.2	<1.0	26.1	<1.0	<0.2	0.0466	<1.0	1.6	<0.2	0.3	<0.0003
MR-MW-6	70	4/26/2007	<0.03	0.03	17	13.6	<1.0	<1.0	1.3	<1.0	<0.2	0.0152	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-6	70	6/12/2007	<0.03	0.03	NM	NM	<1.0	<1.0	0.7	<1.0	<0.2	0.0147	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-6	70	9/25/2007	<0.03	0.03	NM	NM	<1.0	<1.0	1.9	2.4	<0.2	0.0179	<1.0	8.3	<0.2	<0.2	<0.0003
MR-MW-6	70	11/12/2007	0.06	0.03	20.3	15.4	2.8	<1.0	1	<1.0	<0.2	0.0163	2.8	1.0	<0.2	0.4	<0.0003
MR-MW-7	70	4/26/2007	<0.03	0.02	21.2	11.4	<1.0	1.6	1.1	<1.0	<0.2	0.0323	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-7	70	6/12/2007	<0.03	0.02	NM	NM	6.1	<1.0	1.4	<1.0	<0.2	0.0377	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-7	70	9/25/2007	<0.03	0.02	NM	NM	<1.0	<1.0	1.4	<1.0	<0.2	0.0542	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-7	70	11/12/2007	0.04	0.02	27.8	17.7	11	2.5	2	<1.0	<0.2	0.0462	6.4	2.7	<0.2	1.2	0.0021
MR-MW-9	70	5/1/2007	<0.03	0.02	47.1	24.6	<1.0	2	2.5	<1.0	<0.2	0.0582	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-9	70	6/12/2007	0.03	0.01	NM	NM	<1.0	<1.0	7.6	<1.0	<0.2	0.0547	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-9	70	9/25/2007	0.09	0.02	NM	NM	<1.0	<1.0	6.7	<1.0	<0.2	0.0584	<1.0	<1.0	<0.2	0.5	<0.0003
MR-MW-9	70	11/15/2007	0.16	0.03	65.2	20.3	3.9	<1.0	5.3	<1.0	<0.2	0.0537	80.0	<1.0	<0.2	1.4	0.0003
MR-MW-11	70	5/4/2007	0.68	0.03	156	47.3	<1.0	<1.0	26	3.5	0.9	0.103	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-11	70	6/20/2007	0.89	0.04	NM	NM	<1.0	<1.0	22	<1.0	<0.2	0.104	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-MW-11	70	10/1/2007	0.92	0.04	107	58.2	2.2	<1.0	22	NM	0.4	0.0896	<1.0	3.1	14.9	<0.2	0.0375
MR-MW-11	70	11/1/2007	0.94	0.04	130	50.6	3.8	4.2	26	<1.0	<0.2	0.0902	<1.0	<1.0	0.3	<0.2	0.0004
MR-PW-1	70	2/16/2007	1.08	0.04	627	78.9	10	<1.0	82.6	2.1	<0.2	0.188					
MR-PW-1	70	6/18/2007	0.05	<0.01	NM	NM	<1.0	<1.0	<0.2	<1.0	<0.2	0.0053	<1.0	<1.0	0.6	<0.2	<0.0003
MR-PW-1	70	10/2/2007	1.05	0.04	NM	NM	1.8	<1.0	88	<1.0	<0.2	0.162	6.1	1.1	3.9	<0.2	<0.0003
MR-PW-1	70	11/15/2007	0.97	0.04	171	52.6	4.7	<1.0	55.8	<1.0	<0.2	0.12	6.0	<1.0	1.2	<0.2	0.0005
MR-885	70	5/2/2007	0.23	0.06	293	147	41	31	309	1.8	<0.2	0.0763	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-885	70	6/15/2007	0.26	0.05	NM	NM	12	12	276	4.3	<0.2	0.11	270.0	290.0	9.3	1.0	<0.003
MR-885	70	10/2/2007	0.20	0.05	NM	NM	12	3.5	272	<1.0	<0.2	0.0758	140.0	110.0	3.1	<0.2	<0.0003
MR-885	70	11/15/2007	0.21	0.05	472	144	20	9.9	263	<1.0	0.4	0.0715	<1.0	98.0	2.5	1.3	0.0003

					Radionuclides												
			Fe (tot.)	Mn (tot.)	G Alpha	G Beta	Pb-210 (dis.)	Po-210 (dis.)	Ra-226 (dis.)	Ra-228 (dis.)	Th-230 (dis.)	U (dis.)	Pb-210 (sus.)	Po-210 (sus.)	Ra-226 (sus.)	Th-230 (sus.)	U (sus.)
Well ID	Completion Zone	Sample Date	(mg/l)	(mg/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(mg/l)	(pCi/l)	(pCi/l)	(pCi/l)	(pCi/l)	(mg/l)
MR-1808	68-70	5/3/2007	<0.03	0.03	30.9	12.8	<1.0	<1.0	9.1	<1.0	0.4	0.0012	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-1808	68-70	6/19/2007	0.28	0.08	NM	NM	<1.0	<1.0	4.9	<1.0	<0.2	0.0005	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-1808	68-70	10/1/2007	0.20	0.07	NM	NM	<1.0	5.3	1.1	<1.0	<0.2	<0.0003	<1.0	<1.0	1.5	<0.2	0.0008
MR-1808	68-70	11/12/2007	0.19	0.06	5.9	9.5	4.9	1.6	1.5	4.3	<0.2	<0.0003	<1.0	<1.0	0.2	<0.2	<0.0003
MR-8-3	68-70	5/2/2007	3.86	0.6	3.6	12.9	<1.0	<1.0	0.8	3	<0.2	0.002	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-8-3	68-70	6/13/2007	3.57	0.53	NM	NM	<1.0	<1.0	1.2	<1.0	<0.2	0.0016	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-8-3	68-70	9/27/2007	3.23	0.52	NM	NM	<1.0	<1.0	0.7	<1.0	<0.2	0.0016	<1.0	6.4	1.5	<0.2	0.001
MR-8-3	68-70	11/15/2007	3.20	0.5	12.2	7.9	8.6	2.3	1.4	4.6	<0.2	0.0017	13.0	18.0	0.6	2.8	0.001
MR-OMW-1	72	4/27/2007	<0.03	<0.01	3.5	20.4	<1.0	<1.0	0.8	2.8	<0.2	0.0014	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-1	72	6/18/2007	<0.03	<0.01	NM	NM	<1.0	<1.0	<0.2	<1.0	<0.2	0.0008	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-1	72	9/26/2007	<0.03	<0.01	NM	NM	<1.0	<1.0	0.8	<1.0	<0.2	0.0009	<1.0	<1.0	<0.2	<0.2	0.0044
MR-OMW-1	72	11/15/2007	0.07	<0.01	4.1	17.3	3.8	1.8	1.1	<1.0	<0.2	0.0009	<1.0	<1.0	<0.2	0.4	<0.0003
MR-OMW-2	72	5/10/2007	0.07	<0.01	9.6	8.6	<1.0	<1.0	1.1	2.5	1	0.0027	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-2	72	6/12/2007	0.10	0.02	NM	NM	<1.0	<1.0	1.2	<1.0	<0.2	0.0026	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-2	72	9/27/2007	0.16	0.09	NM	NM	<1.0	<1.0	0.6	<1.0	<0.2	0.0016	<1.0	<1.0	<0.2	<0.2	0.0006
MR-OMW-2	72	11/13/2007	0.07	0.06	7.8	10.3	<1.0	2.6	3	<1.0	<0.2	0.0018	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-3	72	4/26/2007	0.05	<0.01	1.8	13.6	<1.0	<1.0	1.1	9.5	<0.2	0.0014	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-3	72	6/14/2007	<0.03	NM	NM	NM	<1.0	<1.0	0.6	<1	<0.2	0.0024	NM	<1.0	<0.2	<0.2	<0.0003
MR-OMW-3	72	9/25/2007	0.09	<0.01	NM	NM	<1.0	<1.0	0.6	<1.0	0.7	0.0017	<1.0	<1.0	<0.2	0.5	<0.0003
MR-OMW-3	72	11/1/2007	0.15	<0.01	5.5	10.6	6.2	1.9	0.7	<1.0	<0.2	0.001	<1.0	<1.0	<0.2	<0.2	0.0005
MR-OMW-4	72	4/30/2007	1.35	0.22	3.5	14.4	<1.0	<1.0	1.8	2	<0.2	0.0008	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-4	72	6/13/2007	1.03	0.18	NM	NM	<1.0	<1.0	2	<1.0	<0.2	0.001	<1.0	<1.0	<0.2	<0.2	<0.0003
MR-OMW-4	72	9/27/2007	1.04	0.18	NM	NM	<1.0	<1.0	1.1	1.6	0.5	0.0011	<1.0	<1.0	2.0	<0.2	0.0007
MR-OMW-4	72	11/20/2007	1.08	0.21	10.1	20.1	8.2	<1.0	1.5	2.2	<0.2	0.0011	<1.0	<1.0	<0.2	0.7	<0.0003
Stockwell #1	70?	4/27/2007	<0.03	0.06	68.2	24	<1.0	<1.0	0.8	1.6	<0.2	0.0508	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #1	70?	6/13/2007	0.14	0.06	NM	NM	<1.0	<1.0	0.6	<1.0	<0.2	0.0446	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #1	70?	10/1/2007	3.10	0.26	NM	NM	<1.0	<1.0	0.7	<1.0	<0.2	0.001	<1.0	4.7	2.0	2.1	0.0005
Stockwell #1	70?	11/20/2007	2.89	0.27	5.5	18	12	<1.0	1	1.8	<0.2	0.0013	1.6	<1.0	<0.2	0.3	<0.0003
Stockwell #2	68?	4/27/2007	3.27	0.25	2	7.9	<1.0	<1.0	0.9	3.9	<0.2	0.0008	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #2	68?	6/13/2007	3.70	0.25	NM	NM	<1.0	<1.0	0.8	<1.0	<0.2	0.0004	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #2	68?	10/1/2007	0.03	0.07	NM	NM	<1.0	<1.0	0.5	<1.0	<0.2	0.049	2.3	<1.0	<0.2	<0.2	<0.0003
Stockwell #2	68?	11/20/2007	<0.03	0.07	52.3	24	10	<1.0	3.6	<1.0	<0.2	0.0451	1.8	<1.0	<0.2	<0.2	<0.0003
Stockwell #3	70?	4/27/2007	9.10	0.46	24.3	16.5	<1.0	<1.0	3.3	3.5	<0.2	0.0077	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #3	70?	6/13/2007	10.00	0.49	NM	NM	<1.0	<1.0	2.8	1.8	<0.2	0.0066	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #3	70?	10/1/2007	5.33	0.37	NM	NM	<1.0	<1.0	3.2	<1.0	<0.2	0.0316	<1.0	<1.0	3.5	<0.2	0.0014
Stockwell #3	70?	11/20/2007	7.04	0.45	27.3	8.4	14	1.9	2.7	2.4	<0.2	0.0175	<1.0	<1.0	<0.2	0.6	0.0003
Stockwell #4	72?	5/9/2007	2.64	0.19	5.9	5.5	<1.0	<1.0	<0.2	<1.0	0.9	0.0071	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #4	72?	6/19/2007	0.37	0.07	NM	NM	<1.0	<1.0	<0.2	<1.0	<0.2	0.0069	<1.0	<1.0	<0.2	<0.2	<0.0003
Stockwell #4	72?	10/1/2007	0.17	0.03	NM	NM	1.5	<1.0	<0.2	<1.0	<0.2	0.0068	<1.0	<1.0	1.5	<0.2	0.0012
Stockwell #4	72?	11/20/2007	0.15	0.02	7	3.7	4	2.4	<0.2	<1.0	<0.2	0.0074	<1.0	<1.0	<0.2	0.3	<0.0003

NOTE STOCKWELL #1 and #2 appear to have been switched going from the 1st and 2nd sampling round to the 3rd and fourth round

< - indicates sample was below reporting limit

tot. - total dis.-dissolved sus.- suspended

Table 2.7.3-20a. Comparison of Historic and Current Baseline Monitoring Analytical Results From Monitor Wells, Moore Ranch Project Area

Well ID	Sample Date	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	SO4 (mg/l)	NO3+ NO2 (mg/l)	F (mg/l)
885	4/12/78	31.5	8.1	208.0	33.5	3.3	281.0	ND	426.0	0.6	0.1
	5/2/2007	40.0	9.0	155.0	34.0	3.0	300.0	ND	370.0	0.3	0.2
	6/15/2007	37.0	8.0	154.0	35.0	3.0	300.0	ND	407.0	ND	0.2
	10/2/2007	38.0	10.0	158.0	35.0	3.0	312.0	ND	375.0	ND	0.1
	11/15/2007	39.0	9.0	168.0	38.0	3.0	312.0	ND	416.0	ND	0.1
	Average	37.1	8.8	168.6	35.1	3.1	301.0	ND	398.8	0.5	0.1
	Max	40.0	10.0	208.0	38.0	3.3	312.0	ND	426.0	0.6	0.2
	Min	31.5	8.0	154.0	33.5	3.0	281.0	ND	370.0	ND	0.1
1808	6/26/79	69.0	9.0	93.0	19.0	10.0	161.0	ND	303.0	0.3	0.2
	9/27/79	69.0	9.0	86.0	17.0	8.0	171.0	ND	300.0	0.4	0.3
	12/15/79	63.0	8.0	84.0	17.0	6.0	159.0	ND	280.0	0.4	0.2
	4/2/80	77.0	10.0	115.0	24.0	8.0	173.0	ND	405.0	0.2	0.2
	5/3/2007	60.0	7.6	104.0	19.5	3.0	179.0	ND	316.0	0.1	0.3
	6/19/2007	64.0	7.0	97.0	19.0	3.0	178.0	ND	322.0	ND	0.3
	10/1/2007	62.0	7.0	104.0	21.0	3.0	184.0	ND	325.0	ND	0.2
	11/12/2007	59.0	7.0	94.0	19.0	3.0	185.0	ND	286.0	ND	0.2
	Average	65.4	8.1	97.1	19.4	5.5	173.8	ND	317.1	0.3	0.2
	Max	77.0	10.0	115.0	24.0	10.0	185.0	ND	405.0	0.4	0.3
	Min	59.0	7.0	84.0	17.0	3.0	159.0	ND	280.0	ND	0.2
8-3	6/28/79	8.0	12.0	354.0	58.0	6.0	361.0	ND	980.0	0.6	ND
	9/27/79	9.0	12.0	278.0	96.0	6.0	371.0	ND	750.0	0.5	0.1
	12/6/79	8.0	13.0	245.0	120.0	6.0	361.0	ND	936.0	0.2	0.1
	4/9/80	10.0	14.0	251.0	115.0	12.0	256.0	ND	860.0	0.2	0.1
	5/2/2007	15.0	12.0	399.0	149.0	ND	370.0	ND	1410.0	0.2	0.1
	6/13/2007	9.0	12.0	408.0	176.0	2.0	359.0	ND	1430.0	ND	ND
	9/27/2007	9.0	13.0	427.0	185.0	1.0	377.0	ND	1440.0	ND	ND
	11/15/2007	9.0	13.0	374.0	146.0	2.0	430.0	ND	1360.0	ND	ND
	Average	9.6	12.6	342.0	130.6	5.0	360.6	ND	1145.8	0.3	0.1
	Max	15.0	14.0	427.0	185.0	12.0	430.0	ND	1440.0	0.6	0.1
	Min	8.0	12.0	245.0	58.0	1.0	256.0	ND	750.0	ND	ND

ND - non detect NA - not applicable (only one value above detection)

Conoco Baseline Monitoring Program

EMC Baseine Monitoring Program

Table 2.7.3-20a. Comparison of Historic and Current Baseline Monitoring Analytical Results From Monitor Wells, Moore Ranch Project Area

Well ID	Sample Date	Al (mg/l)	NH4 (mg/l)	As (mg/l)	Ba (mg/l)	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)
885	4/12/78	ND	ND	0.004	0.19	0.2	ND	ND	0.66		0.23
	5/2/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.15	0.05
	6/15/2007	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06
	10/2/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.11	0.05
	11/15/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.14	0.05
	Average	ND	ND	NA	NA	NA	ND	ND	NA	0.13	0.09
	Max	ND	ND	0.004	0.19	0.20	ND	ND	0.66	0.15	0.23
	Min	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05
1808	6/26/79	ND	0.38	ND	ND	ND	ND	ND	0.13	ND	0.09
	9/27/79	ND	1.02	ND	ND	ND	ND	0.003	0.21	ND	0.13
	12/15/79	ND	0.10	ND	ND	ND	ND	0.005	0.11	ND	0.06
	4/2/80	ND	ND	ND	ND	ND	ND	ND	ND	0.07	0.05
	5/3/2007	ND	0.06	ND	ND	ND	ND	ND	ND	ND	0.03
	6/19/2007	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06
	10/1/2007	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06
	11/12/2007	ND	ND	0.002	ND	ND	ND	ND	ND	ND	0.05
	Average	ND	0.5	NA	ND	ND	ND	0.004	0.15	NA	0.07
	Max	ND	1.0	0.00	ND	ND	ND	0.005	0.21	0.07	0.13
	Min	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.03
8-3	6/28/79	ND	0.11	ND	ND	ND	ND	ND	1.96	ND	0.33
	9/27/79	ND	0.81	ND	ND	ND	ND	0.004	2.4	ND	0.33
	12/6/79	ND	0.47	ND	ND	ND	ND	0.002	2.65	0.07	0.33
	4/9/80	ND	0.11	ND	ND	ND	0.006	0.010	3.75	0.08	0.32
	5/2/2007	ND	1.62	ND	ND	ND	ND	ND	ND	3.34	0.53
	6/13/2007	ND	0.24	ND	ND	ND	ND	ND	ND	1.08	0.52
	9/27/2007	ND	2.72	ND	ND	ND	ND	ND	ND	2.66	0.52
	11/15/2007	ND	13.2	ND	ND	ND	ND	ND	ND	2.35	0.49
	Average	ND	2.41	ND	ND	ND	NA	0.005	2.69	1.60	0.42
	Max	ND	13.20	ND	ND	ND	0.006	0.010	3.75	3.34	0.53
	Min	ND	0.11	ND	ND	ND	ND	ND	ND	ND	0.32

ND - non detect NA - not applicable (only one value above detection)

Conoco Baseline Monitoring Program

EMC Baseine Monitoring Program

Table 2.7.3-20a. Comparison of Historic and Current Baseline Monitoring Analytical Results From Monitor Wells, Moore Ranch Project Area

Well ID	Sample Date	Hg (mg/l)	Mo (mg/l)	Ni (mg/l)	Se (mg/l)	V (mg/l)	Zn (mg/l)	TDS@ 180F (mg/l)	Conductivity (umhos/cm)	pH s.u.	Ra-226 (pCi/L)	U (mg/l)
885	4/12/78	0.00003	0.002	0.02	ND	ND	0.03	836	1113	7.53	163	0.056
	5/2/2007	ND	ND	ND	ND	ND	ND	842	1203	7.17	309	0.0763
	6/15/2007	ND	ND	ND	0.002	ND	ND	802	1150	7.55	276	0.110
	10/2/2007	ND	ND	ND	ND	ND	ND	844	1230	7.40	272	0.0758
	11/15/2007	ND	ND	ND	ND	ND	ND	850	1210	7.64	263	0.0715
	Average	NA	NA	NA	NA	ND	NA	835	1181	7.46	280	0.0779
	Max	0.00003	0.002	0.02	0.002	ND	0.03	850	1230	7.64	309	0.1100
	Min	ND	ND	ND	ND	ND	ND	802	1113	7.17	263	0.0560
1808	6/26/79	ND	ND	ND	ND	ND	0.02	573	800	7.20	0.6	-
	9/27/79	ND	ND	ND	ND	ND	0.02	570	789	6.45	-	-
	12/15/79	ND	ND	ND	ND	ND	0.08	608	813	7.65	-	-
	4/2/80	ND	ND	ND	ND	ND	ND	684	986	8.20	-	-
	5/3/2007	ND	ND	ND	0.003	ND	ND	602	976	8.10	9.1	0.0012
	6/19/2007	ND	ND	ND	0.001	ND	ND	638	916	7.38	4.9	0.0005
	10/1/2007	ND	ND	ND	ND	ND	ND	584	915	7.82	1.1	ND
	11/12/2007	ND	ND	ND	ND	ND	ND	570	903	7.66	1.5	ND
	Average	ND	ND	ND	0.002	ND	0.04	604	887	7.56	3.4	0.0009
	Max	ND	ND	ND	0.003	ND	0.08	684	986	8.20	9.1	0.0012
	Min	ND	ND	ND	ND	ND	ND	570	789	6.45	0.6	ND
8-3	6/28/79	ND	ND	ND	ND	ND	0.05	1460	1610	6.85	0.6	71*
	9/27/79	ND	ND	ND	ND	ND	0.02	1426	1660	6.50	-	-
	12/6/79	ND	ND	ND	ND	ND	0.01	1566	1680	7.75	-	-
	4/9/80	ND	ND	ND	ND	ND	-	1398	1750	7.10	-	-
	5/2/2007	ND	ND	ND	0.001	ND	ND	2270	2740	6.93	0.8	0.002
	6/13/2007	ND	ND	ND	0.001	ND	ND	2380	2660	7.13	1.2	0.0016
	9/27/2007	ND	ND	ND	0.001	ND	ND	2310	2610	7.21	0.7	0.0016
	11/15/2007	ND	ND	ND	ND	ND	ND	2240	2540	7.51	1.4	0.0017
	Average	ND	ND	ND	0.001	ND	0.02	1881	2156	7.12	0.9	0.0017
	Max	ND	ND	ND	0.001	ND	0.05	2380	2740	7.75	1.4	0.0020
	Min	ND	ND	ND	ND	ND	ND	1398	1610	6.50	0.6	0.0016

* Uranium value appears inconsistent with subsequent values collected at same location and is not used in calculation of average, maximum or minimum

Conoco Baseline Monitoring Program (blue) — ND - non detect — NA - not applicable (only one value above detection)

EMC Baseine Monitoring Program (yellow)

Table 2.7.3-20b. Comparison of Historic and Current Baseline Monitoring Analytical Results From Private Wells, Moore Ranch Project Area

Well ID	Sample Date	Al (mg/l)	NH4 (mg/l)	As (mg/l)	Ba (mg/l)	B (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Mn (mg/l)	Hg (mg/l)	Ra-226 (pCi/L)	U (mg/l)*
Stockwell #1 (T-1)	6/26/1979	ND	ND	ND	ND	ND	ND	ND	ND	0.17	0.01	0.02	ND	0.41	0.0004
	9/18/1979	ND	ND	ND	ND	ND	ND	ND	0.005	0.23	0.12	0.06	ND	0.20	0.0310
	4/27/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.20	ND	0.06	ND	0.80	0.0508
	6/13/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.20	ND	0.05	ND	0.60	0.0446
	10/1/2007	ND	0.06	ND	ND	ND	ND	ND	ND	ND	2.05	0.25	ND	0.70	0.0010
	11/20/2007	ND	0.07	ND	ND	ND	ND	ND	ND	0.1	0.89	0.25	ND	1.00	0.0013
	Average	ND	0.065	ND	ND	ND	ND	ND	NA	0.18	0.77	0.11	ND	0.62	0.0215
	Max	ND	0.07	ND	ND	ND	ND	ND	0.005	0.23	2.05	0.25	ND	1.00	0.0508
	Min	ND	ND	ND	ND	ND	ND	ND	ND	0.10	ND	0.02	ND	0.20	0.0004
Stockwell #2 (P'-11)	8/16/1979	ND	0.06	ND	ND	ND	0.008	ND	0.009	0.14	0.02	0.02	ND		
	4/27/2007	ND	0.05	ND	ND	ND	ND	ND	ND	0.20	0.03	0.24	ND	0.90	0.0008
	6/13/2007	ND	0.05	ND	ND	ND	ND	ND	ND	0.10	0.58	0.25	ND	0.80	0.0004
	10/1/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.20	ND	0.07	ND	0.50	0.0490
	11/20/2007	ND	ND	ND	ND	ND	ND	ND	ND	0.20	ND	0.06	ND	3.60	0.0451
	Average	ND	0.05	ND	ND	ND	NA	ND	NA	0.17	0.21	0.13	ND	1.45	0.0238
	Max	ND	0.06	ND	ND	ND	0.008	ND	0.009	0.20	0.58	0.25	ND	3.60	0.0490
	Min	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.02	ND	0.50	0.0004
Stockwell #3 (P'-9)	6/20/1979	ND	ND	ND	ND	ND	ND	ND	ND	0.13	0.07	0.09	ND	2.00	0.0473
	9/27/1979	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	0.07	ND	2.10	0.0325
	3/26/1980	ND	0.10	ND	ND	ND	ND	ND	0.01	0.12	0.07	0.08	ND	-	-
	4/27/2007	ND	0.10	ND	ND	ND	ND	ND	ND	0.20	4.86	0.46	ND	3.30	0.0077
	6/13/2007	ND	0.14	ND	ND	ND	ND	ND	ND	0.20	0.24	0.46	ND	2.80	0.0066
	10/1/2007	ND	0.1	ND	ND	ND	ND	ND	0.01	0.10	3.48	0.37	ND	3.20	0.0316
	11/20/2007	ND	0.15	ND	ND	ND	ND	ND	ND	0.20	3.11	0.42	ND	2.70	0.0175
	Average	ND	0.12	ND	ND	ND	ND	ND	0.01	0.16	1.97	0.28	ND	2.68	0.0239
	Max	ND	0.15	ND	ND	ND	ND	ND	0.01	0.20	4.86	0.46	ND	3.30	0.0473
	Min	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.07	ND	2.00	0.0066

Conoco Baseline Monitoring Program (dark blue shading) ND - non detect NA - not applicable (only one value above detection)

EMC Baseline Monitoring Program (yellow shading)

Note-Stockwell #1 and #2 appear to have been switched going from the 1st and 2nd sampling round to the 3rd and 4th round for the EMC Baseline Monitoring Program

* - U values from Conoco data were reported in pCi/L and converted to mg/l by a conversion factor of 677 pCi = 1 mg

Table 2.7.3-21 Comparison of Moore Ranch Monitoring Results to Water Quality Standards

	MAJOR CATIONS/ANIONS											
	Na	**K**	**Ca**	**Mg**	**Cl**	**HC03**	**CO3**	**SO4**	**NH4**	**NO2+ NO3 (N)**	**F**	**SiO2**
WYO Class I Standard	NA	NA	NA	NA	250	NA	NA	250	0.5	NA[3]	4	NA
EPA MCL	NA	NA	NA	NA	NA[1]	NA	NA	NA[2]	NA	NA[3]	4	NA
All Aquifers (68, 70 and 72)												
Number of Samples	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#
Average	39.1	12.4	132.9	34.9	2.6	238.0	2.9	371.7	0.4	0.2	0.2	11.9
Max	88	26	427	185	8	430	67	1440	13.2	3.7	0.4	17.3
Min	9	6	9	1	1	1	1	65	0.05	0.1	0.1	3.4
No. Samples> WDEQ Class I	NA	NA	NA	NA	0	NA	NA	**38**	**8**	NA	0	NA
No. Samples> MCL	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	0	NA
68 Sand Monitor Wells												
Number of Samples	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**
Average	63.4	14.7	54.4	7.4	2.0	148.6	10.4	162.0	0.5	0.3	0.2	11.2
Max	88	26	109	27	5	269	67	245	3.11	0.8	0.3	17.3
Min	34	9	9	1	1	1	1	96	0.05	0.1	0.1	6.3
No. Samples> WDEQ Class I	NA	NA	NA	NA	0	NA	NA	0	**3**	NA	0	NA
No. Samples> MCL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
70 Sand Monitor Wells												
Number of Samples	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*
Average	33.3	10.2	135.2	31.8	2.3	277.2	1.0	330.3	0.1	0.2	0.2	13.0
Max	62	16	236	64	5	317	1	665	0.2	1.5	0.4	15.3
Min	13	6	67	14	1	159	1	76	0.1	0.1	0.1	9.9
No. Samples> WDEQ Class I	NA	NA	NA	NA	0	NA	NA	**22**	0	NA	0	NA
No. Samples> MCL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
72 Sand Monitor Wells												
Number of Samples	16	16	16	16	16	16	16	16	16	16	16	16
Average	32.3	16.6	137.4	37.3	4.1	208.2	1.6	401.0	0.214	0.4	0.2	10.9
Max	73	26	250	89	8	333	7	743	0.6	3.7	0.2	16.1
Min	14	10	53	9	1	45	1	65	0.1	0.1	0.1	3.4
No. Samples> WDEQ Class I	NA	NA	NA	NA	0	NA	NA	**8**	**2**	NA	0	NA
No. Samples> MCL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA

Table 2.7.3-21 Comparison of Moore Ranch Monitoring Results to Water Quality Standards

	TRACE METALS															
	Al	**As**	**Ba**	**B**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Mo**	**Ni**	**Se**	**V**	**Zn**
WYO Class I Standard	NA	0.050	2	0.75	0.005	0.1	1	0.3	0.015	0.05	0.002	NA	NA	0.05	NA	5
EPA MCL	NA[4]	0.010	2	NA	0.005	0.1	NA[5]	NA[6]	0.015	NA[7]	0.002	NA	NA	0.05	NA	NA[8]
All Aquifers (68, 70 and 72)																
Number of Samples	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#
Average	0.1	0.002	0.1	0.1	0.005	0.05	0.01	0.23	0.00	0.06	0.001	0.1	0.05	0.038	0.1	0.01
Max	0.1	0.006	0.1	0.1	0.005	0.05	0.03	3.34	0.032	0.53	0.001	0.1	0.05	0.527	0.1	0.02
Min	0.1	0.001	0.1	0.1	0.005	0.05	0.01	0.03	0.001	0.01	0.001	0.1	0.05	0.001	0.1	0.01
No. Samples> WDEQ Class I	NA	0	0	0	0	0	0	**15**	**3**	**14**	0	NA	NA	**10**	NA	0
No. Samples> MCL	NA	0	0	NA	0	0	NA	NA	**3**	NA	0	NA	NA	**10**	NA	NA
68 Sand Monitor Wells																
Number of Samples	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**
Average	0.1	0.002	0.1	0.1	0.005	0.05	0.011	0.052	0.005	0.016	0.001	0.1	0.05	0.135	0.1	0.01
Max	0.1	0.006	0.1	0.1	0.005	0.05	0.030	0.310	0.027	0.030	0.001	0.1	0.05	0.458	0.1	0.01
Min	0.1	0.001	0.1	0.1	0.005	0.05	0.010	0.030	0.001	0.010	0.001	0.1	0.05	0.001	0.1	0.01
No. Samples> WDEQ Class I	NA	0	0	0	0	0	0	1	2	0	0	NA	NA	**7**	NA	0
No. Samples> MCL	NA	0	0	NA	0	0	NA	NA	2	NA	0	NA	NA	**7**	NA	NA
70 Sand Monitor Wells																
Number of Samples	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*	35*
Average	0.1	0.002	0.1	0.1	0.005	0.05	0.010	0.151	0.002	0.033	0.001	0.1	0.05	0.025	0.1	0.01
Max	0.1	0.005	0.1	0.1	0.005	0.05	0.010	0.850	0.032	0.060	0.001	0.1	0.05	0.527	0.1	0.02
Min	0.1	0.001	0.1	0.1	0.005	0.05	0.010	0.030	0.001	0.010	0.001	0.1	0.05	0.001	0.1	0.01
No. Samples> WDEQ Class I	NA	0	0	0	0	0	0	**9**	**1**	**2**	0	NA	NA	**3**	NA	0
No. Samples> MCL	NA	0	0	NA	0	0	NA	NA	**1**	NA	0	NA	NA	**3**	NA	NA
72 Sand Monitor Wells																
Number of Samples	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Average	0.1	0.001	0.1	0.1	0.005	0.05	0.010	0.082	0.001	0.064	0.001	0.1	0.05	0.001	0.1	0.01
Max	0.1	0.003	0.1	0.1	0.005	0.05	0.010	0.460	0.001	0.220	0.001	0.1	0.05	0.003	0.1	0.02
Min	0.1	0.001	0.1	0.1	0.005	0.05	0.010	0.030	0.001	0.010	0.001	0.1	0.05	0.001	0.1	0.01
No. Samples> WDEQ Class I	NA	0	0	0	0	0	0	**2**	0	**6**	0	NA	NA	0	NA	0
No. Samples> MCL	NA	0	0	NA	0	0	NA	NA	0	NA	0	NA	NA	0	NA	NA

Table 2.7.3-21 Comparison of Moore Ranch Monitoring Results to Water Quality Standards

	General Water Quality Parameters			Radionuclides												
	TDS	Conduct.	pH (units)	Gross Alpha	Gross Beta	Pb-210	Po-210	Ra-226	Ra-228	Th-230	U	Pb-210 (sus.)	Po-210 (sus.)	Ra-226 (sus.)	Th-230 (sus.)	U (sus.)
WYO Class I Standard	500	NA	6.5-8.5	15*	NA	NA	NA	5[a]	5[a]	NA	NA	NA	NA	NA	NA	NA
EPA MCL	NA[9]	NA	NA[10]	NA*	NA	NA	NA	5[a]	5[a]	NA	0.03	NA	NA	NA	NA	NA
All Aquifers (68, 70 and 72)																
Number of Samples	73#	73#	73#	44#	44#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#	73#
Average	749.2	1066.1	7.94	147.6	52.3	6.4	3.8	50.4	1.7	0.3	0.087	9.9	9.7	1.6	1.0	0.0053
Max	2380	2740	12	1050	327	69	51	335.0	9.5	1.0	0.884	270.0	290.0	40.6	43.7	0.2360
Min	240	316	7	2	8	1	1	0.2	1.0	0.2	0.000	1.0	1.0	0.2	0.2	0.0003
No. Samples> WDEQ Class I	**47**	NA	**9**	**25**	NA	NA	NA	**28**	**2**	NA	NA	NA	NA	NA	NA	NA
No. Samples> MCL	NA	NA	**9**	NA	NA	NA	NA	**28**	**2**	NA	**39**	NA	NA	NA	NA	NA
68 Sand Monitor Wells																
Number of Samples	14**	14**	14**	8**	8**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**	14**
Average	416.5	753.3	8.99	78.24	40.09	6.81	3.55	21.1	1.2	0.2	0.050	2.1	3.7	3.2	3.3	0.0182
Max	570	1620	11.5	370.0	162.0	69.0	34.0	280.0	3.3	0.2	0.112	15.0	23.0	40.6	43.7	0.2360
Min	240	316	7.4	3.40	12.80	1.00	1.00	0.2	1.0	0.2	0.000	1.0	1.0	0.2	0.2	0.0003
No. Samples> WDEQ Class I	**4**	NA	**6**	**5**	NA	NA	NA	2	0	NA	NA	NA	NA	NA	NA	NA
No. Samples> MCL	NA	NA	**6**	NA	NA	NA	NA	2	0	NA	**9**	NA	NA	NA	NA	NA
70 Sand Monitor Wells																
Number of Samples	35*	35*	35*	20*	20*	35*	35*	35*	34*	35*	35*	34*	34*	34*	34*	34*
Average	712.5	1034.2	7.58	259.1	80.6	9.2	5.6	95.6	1.7	0.3	0.161	18.8	17.6	1.8	0.5	0.0033
Max	1200	1590	8	1050	327	69	51	335.0	5.9	0.9	0.884	270.0	290.0	14.9	7.3	0.0519
Min	298	514	7	4	11	1	1	0.7	1.0	0.2	0.000	1.0	1.0	0.2	0.2	0.0003
No. Samples> WDEQ Class I	**27**	NA	0	**19**	NA	NA	NA	**25**	**1**	NA	NA	NA	NA	NA	NA	NA
No. Samples> MCL	NA	NA	0	NA	NA	NA	NA	**25**	**1**	NA	**30**	NA	NA	NA	NA	NA
72 Sand Monitor Wells																
Number of Samples	16	16	16	8	8	16	16	16	16	16	16	15	16	16	16	16
Average	770.6	1051.6	8.07	5.7	14.4	2.0	1.2	1.1	1.9	0.3	0.001	1.0	1.0	0.3	0.3	0.0006
Max	1350	1700	9	10	20	8	3	3.0	9.5	1.0	0.003	1.0	1.0	2.0	0.7	0.0044
Min	310	527	7	2	9	1	1	0.2	1.0	0.2	0.001	1.0	1.0	0.2	0.2	0.0003
No. Samples> WDEQ Class I	**8**	NA	**3**	0	NA	NA	NA	0	**1**	NA	NA	NA	NA	NA	NA	NA
No. Samples> MCL	NA	NA	**3**	NA	NA	NA	NA	0	**1**	NA	0	NA	NA	NA	NA	NA

Table 2.7.3-21 Comparison of Moore Ranch Monitoring Results to Water Quality Standards

#Includes 8 samples collected from wells that are completed across the 68 and 70 sand within the same borehole
*One sample from PW-1 (collected 6/18/07) was not consistent with sample results from other wells and three other samples collected from PW-1. The results from that sample analysis were not included in the totals
**One sample from UMW-3 (collected 6/20/07) was not consistent with sample results from other wells and one other sample collected from UMW-3. The results from that sample analysis were not included in the totals
Samples that were below detection were valued at the detection limit for purposes of calculating the average.
All samples were reported as non-detect for Al, Ba, B, Cd, Cr, Cu, Hg, Mo, Ni and V.

1 - EPA Secondary Drinking Water Standard for chloride is 250 mg/l
2 - EPA Secondary Drinking Water Standard for sulfate is 250 mg/l
3 - WDEQ Class I and EPA MCL standards for Nitrate (as N) and Nitrite (as N) are 10 mg/l and 1 mg/l respectively. Only two samples exceeded the lower 1.0 mg/l standard.
4 - EPA Secondary Drinking Water Standard for aluminum is 0.05 to 2.0 mg/l
5 - EPA Secondary Drinking Water Standard for copper is1.0 mg/l
6 - EPA Secondary Drinking Water Standard for iron is 0.3 mg/l
7 - EPA Secondary Drinking Water Standard for manganese is 0.05 mg/l
8 - EPA Secondary Drinking Water Standard for zinc is 5.0 mg/l
9 - EPA Secondary Drinking Water Standard for TDS is 500 mg/l
10 - EPA Secondary Drinking Water Standard for pH is 6.5 to 8.5 s.u.
[a] - Radium standards are for combined Ra226 +228. Only two samples exceeded the standard based only on the Radium 228 concentration.
All other samples that exceeded the combined standard did so based only on the Ra226 concentration.

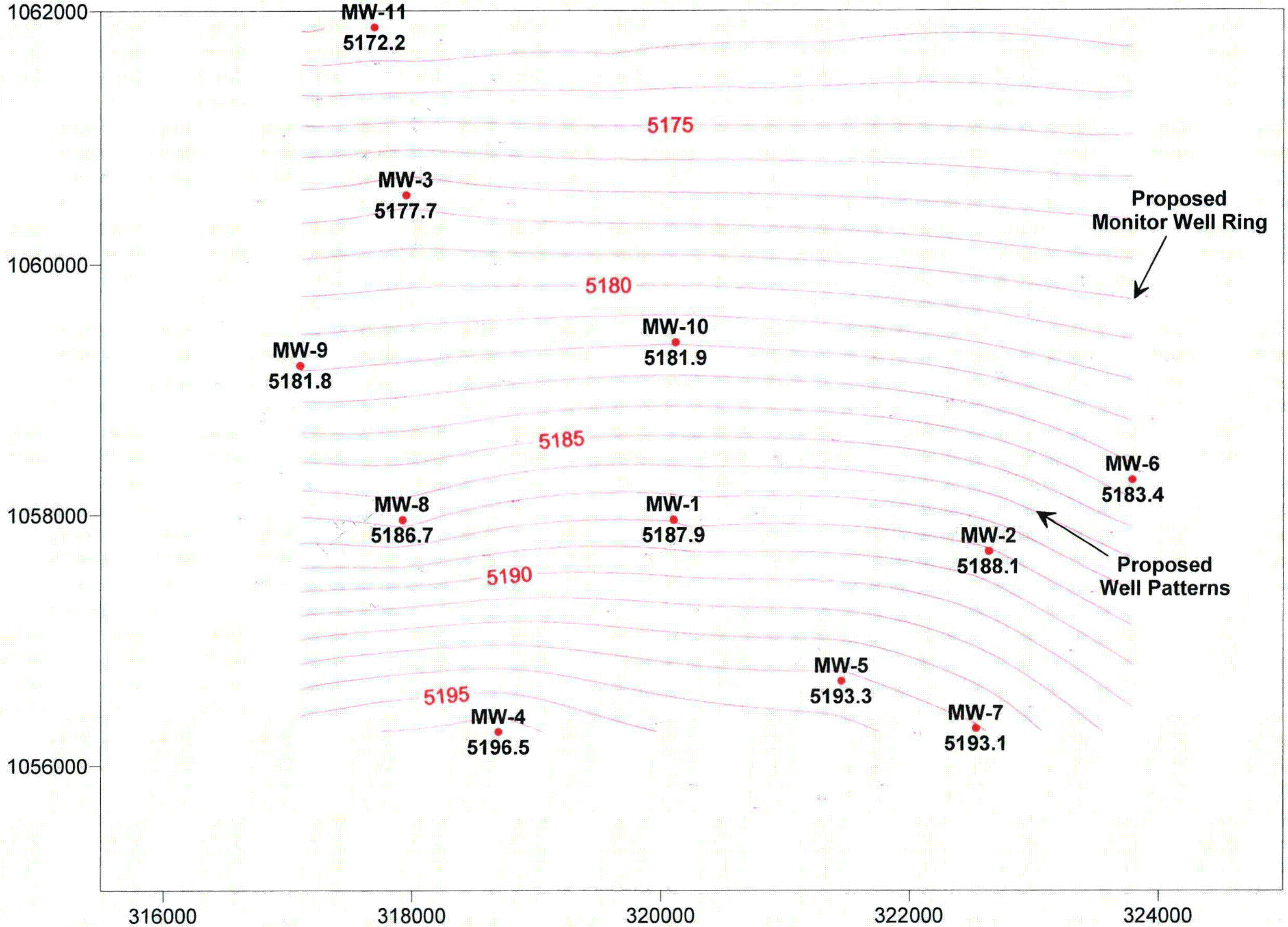
THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: DRAWING NO.: FIGURE 2.7-12

"MOORE RANCH URANIUM PROJECT COAL BED METHANE WELLS & OUTFALL LOCATIONS",

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT DRAWING NO.

D-16



MW1 Well ID
Baseline Monitor Well
5116.4 Water Level Elevation
Potentiometric Surface
Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-5a. 02/14/07 Potentiometric Surface, 70 Sand
Moore Ranch Uranium Project, Wyoming

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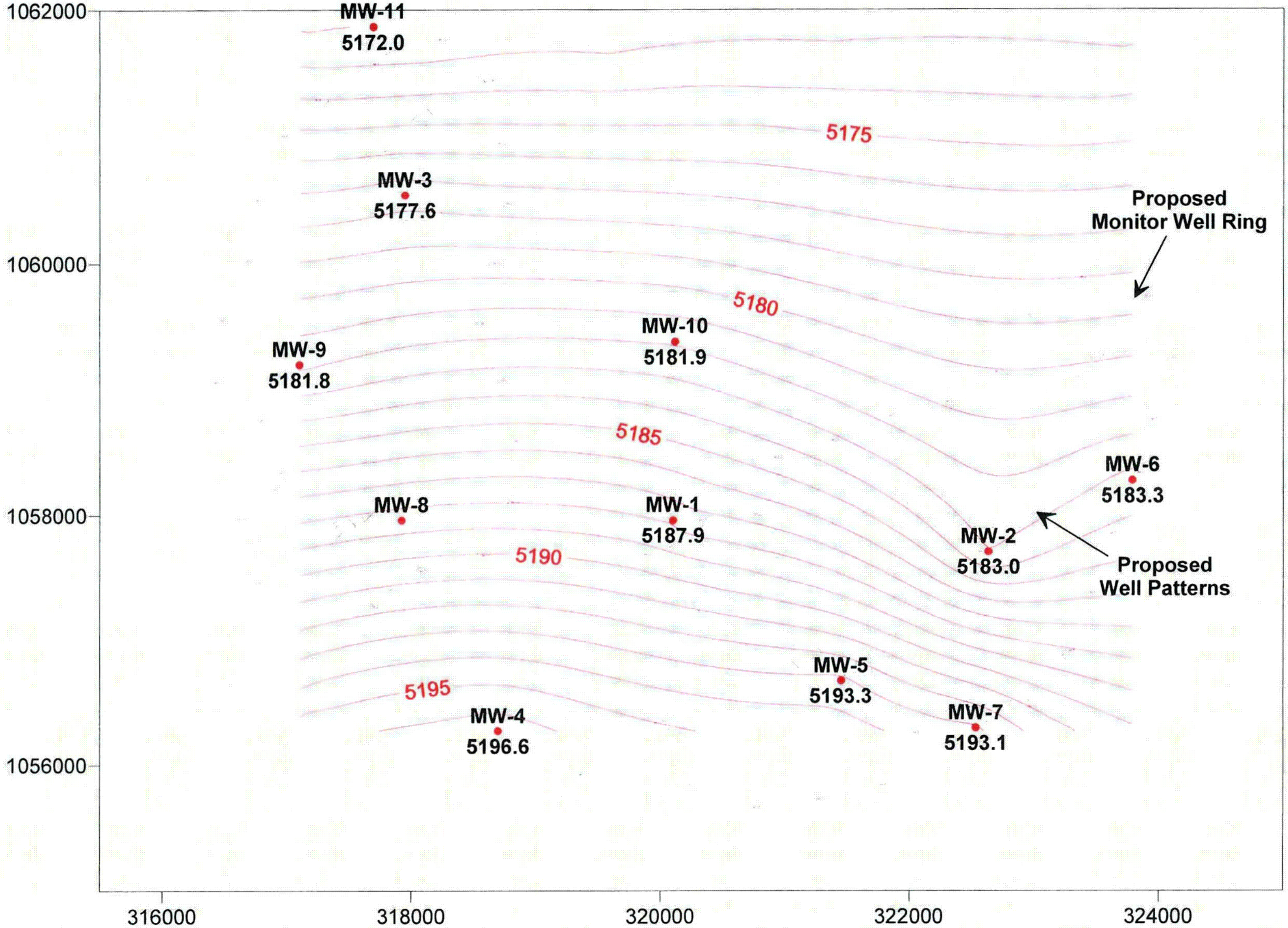

MW1	Well ID
	Baseline Monitor Well
5116.4	Water Level Elevation
	Potentiometric Surface Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-5b 06/12/07 Potentiometric Surface, 70 Sand
Moore Ranch Uranium Project, Wyoming

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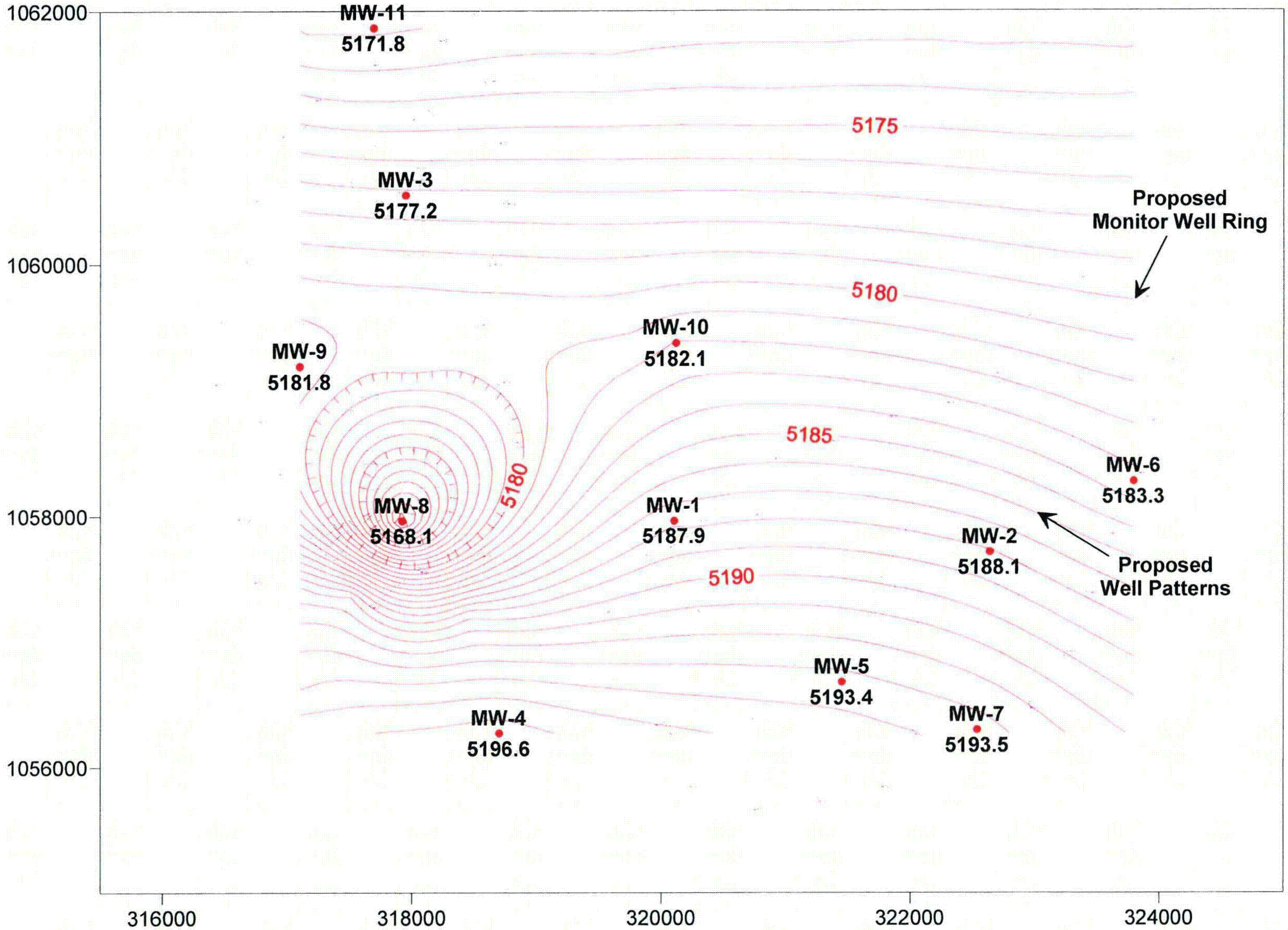

MW1 Well ID
Baseline Monitor Well
5116.4 Water Level Elevation
Potentiometric Surface
Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-5c 07/17/07 Potentiometric Surface, 70 Sand
Moore Ranch Uranium Project, Wyoming

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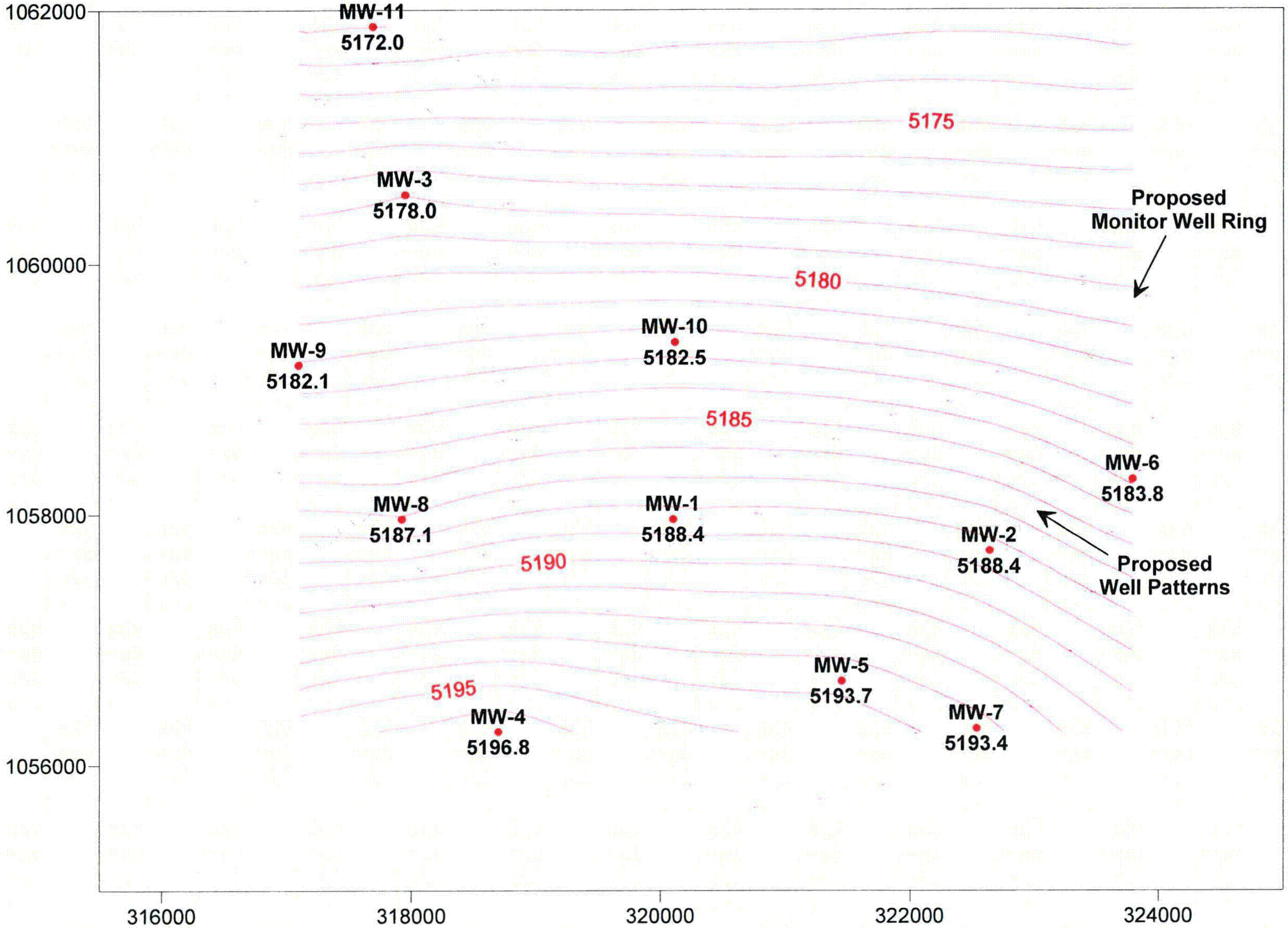

MW1 Well ID
Baseline Monitor Well
5116.4 Water Level Elevation
Potentiometric Surface
Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-5d. 02/21/08 Potentiometric Surface, 70 Sand
Moore Ranch Uranium Project, Wyoming

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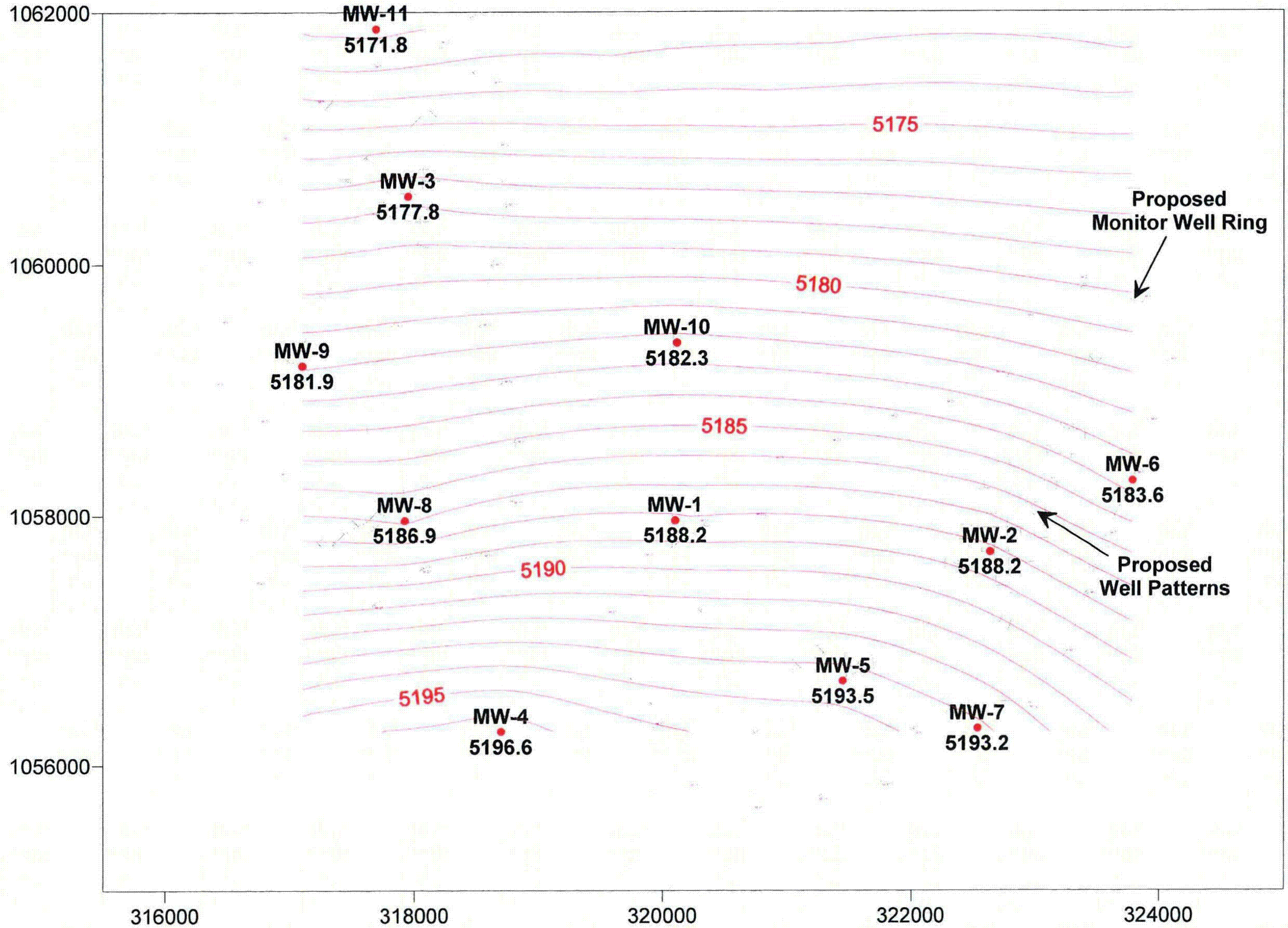

MW1	Well ID
●	Baseline Monitor Well
5116.4	Water Level Elevation
(contour line)	Potentiometric Surface Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-5e. 03/05/08 Potentiometric Surface, 70 Sand
Moore Ranch Uranium Project, Wyoming

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Figure 2.7.2-5f. Hydrographs of 70 Sand Baseline Wells, West Permit Area
Moore Ranch, Wyoming

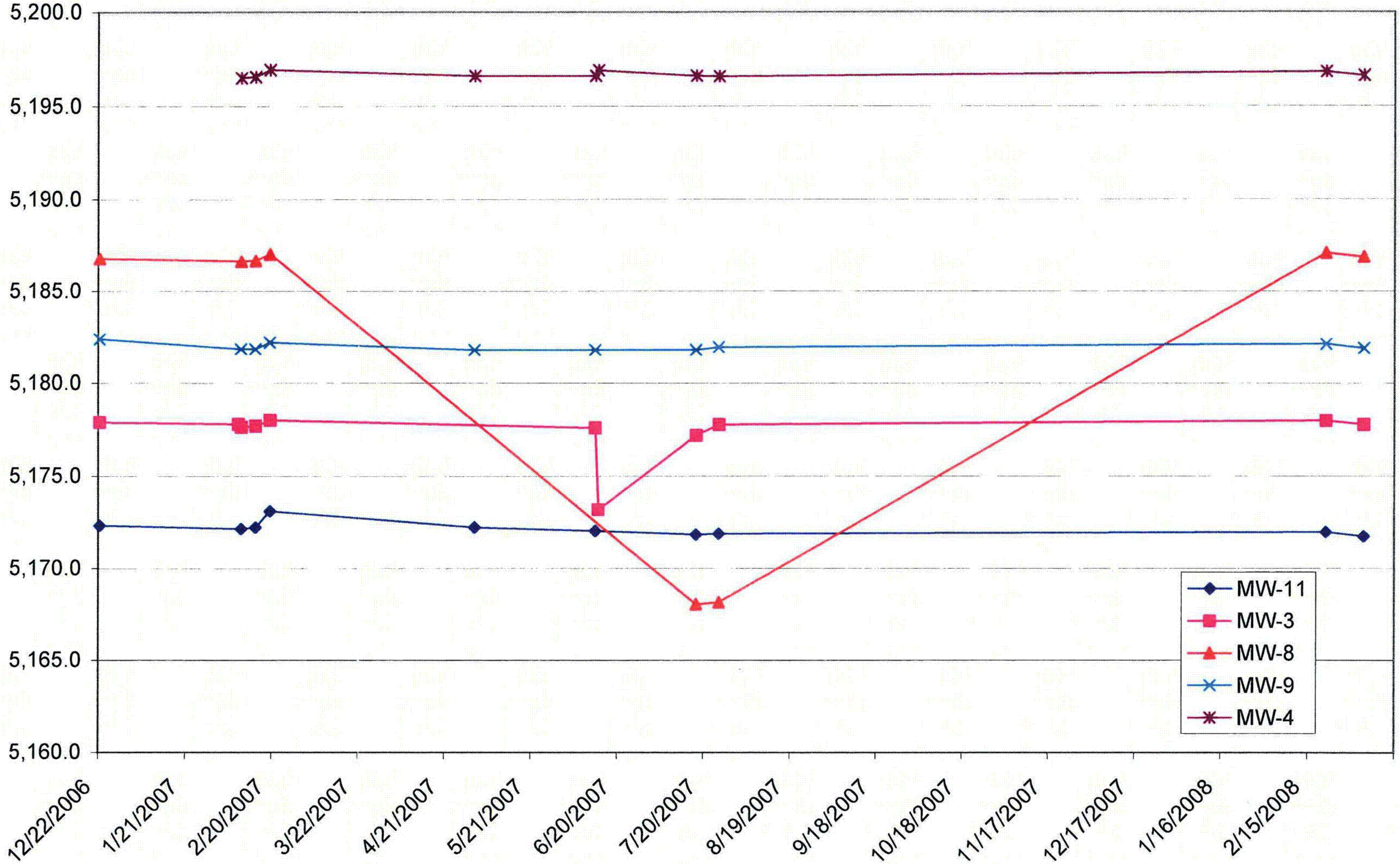
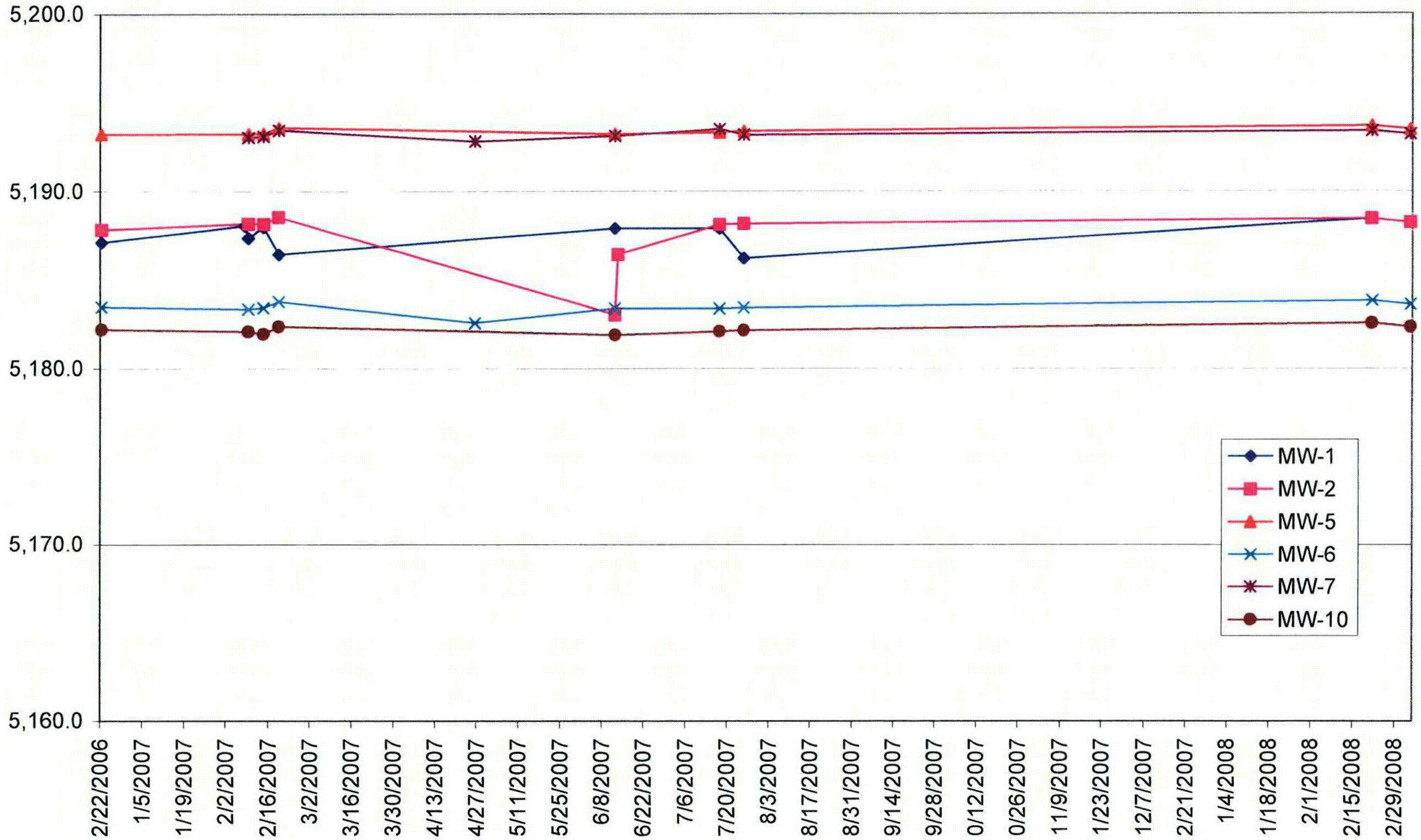
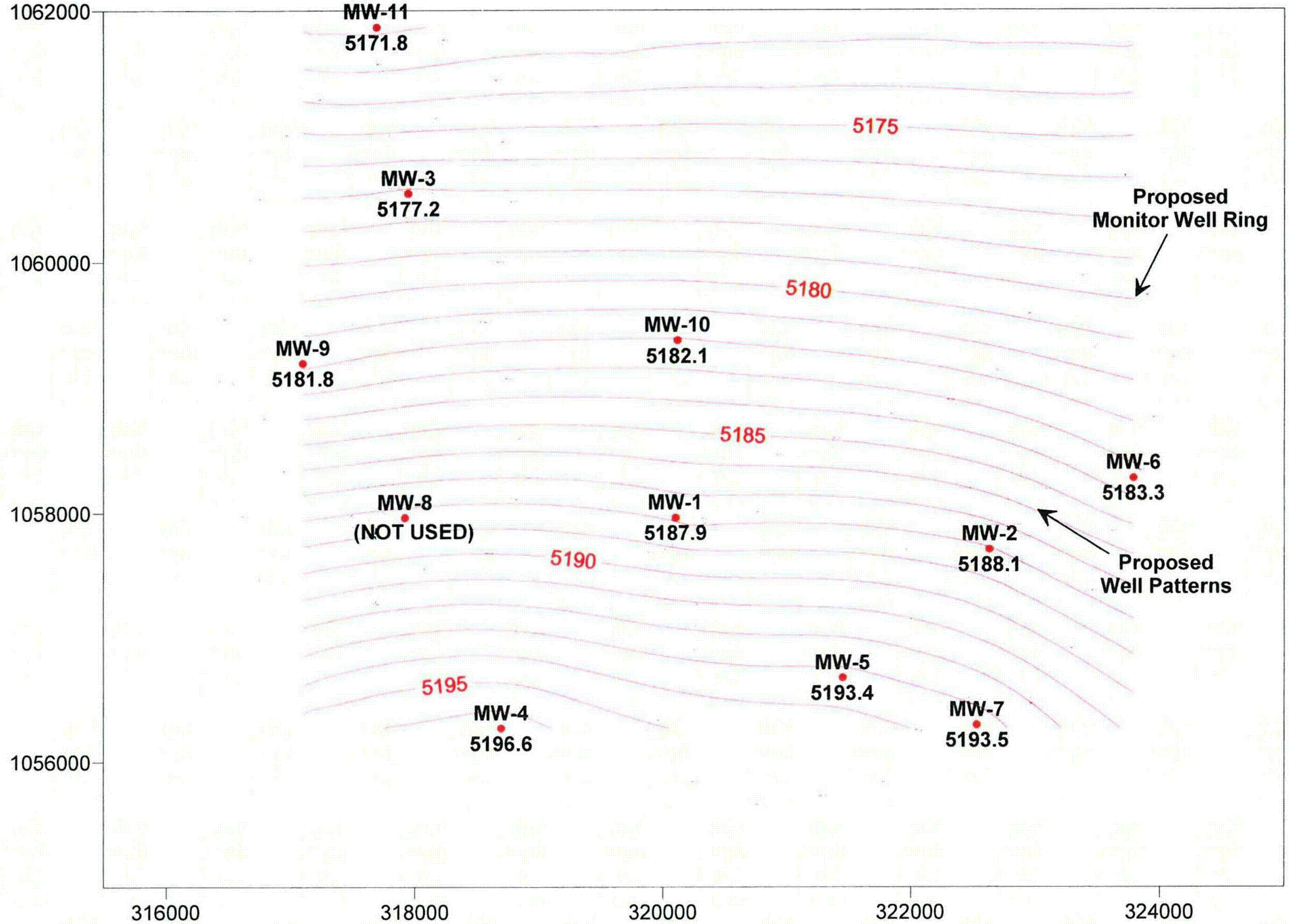


Figure 2.7.2-5g. Hydrographs of 70 Sand Baseline Wells, East Permit Area Moore Ranch, Wyoming





MW1 Well ID
Baseline Monitor Well
5116.4 Water Level Elevation
Potentiometric Surface
Contour Interval = 1 ft

0 500 1000
(feet)

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Figure Figure 2.7.2-5h. 07/17/07 Potentiometric Surface, 70 Sand Withough MW8 Data
Moore Ranch Uranium Project, Wyoming

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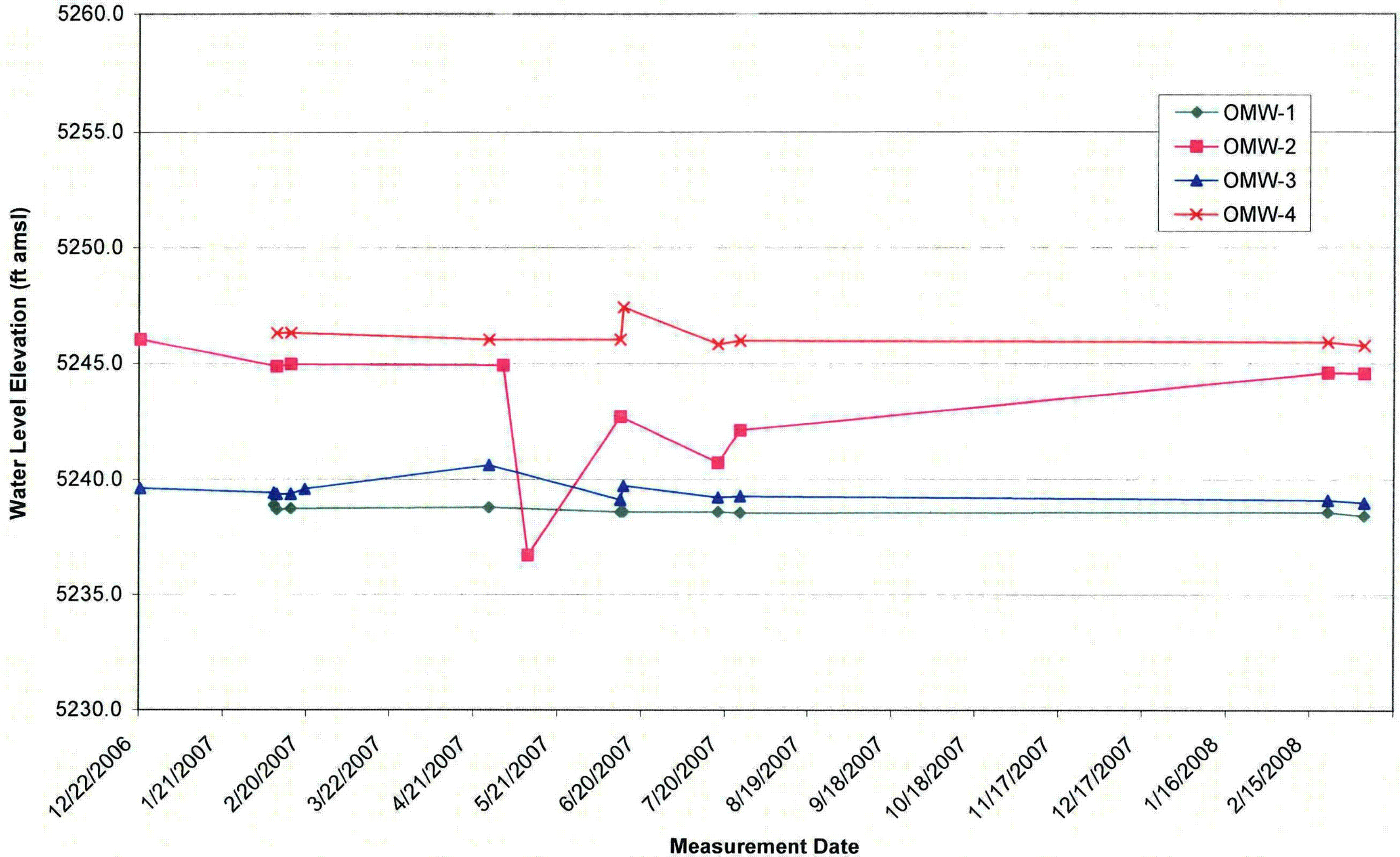
Figure 2.7.2-6a Hydrographs of 72 Sand Baseline Wells, Moore Ranch, Wyoming



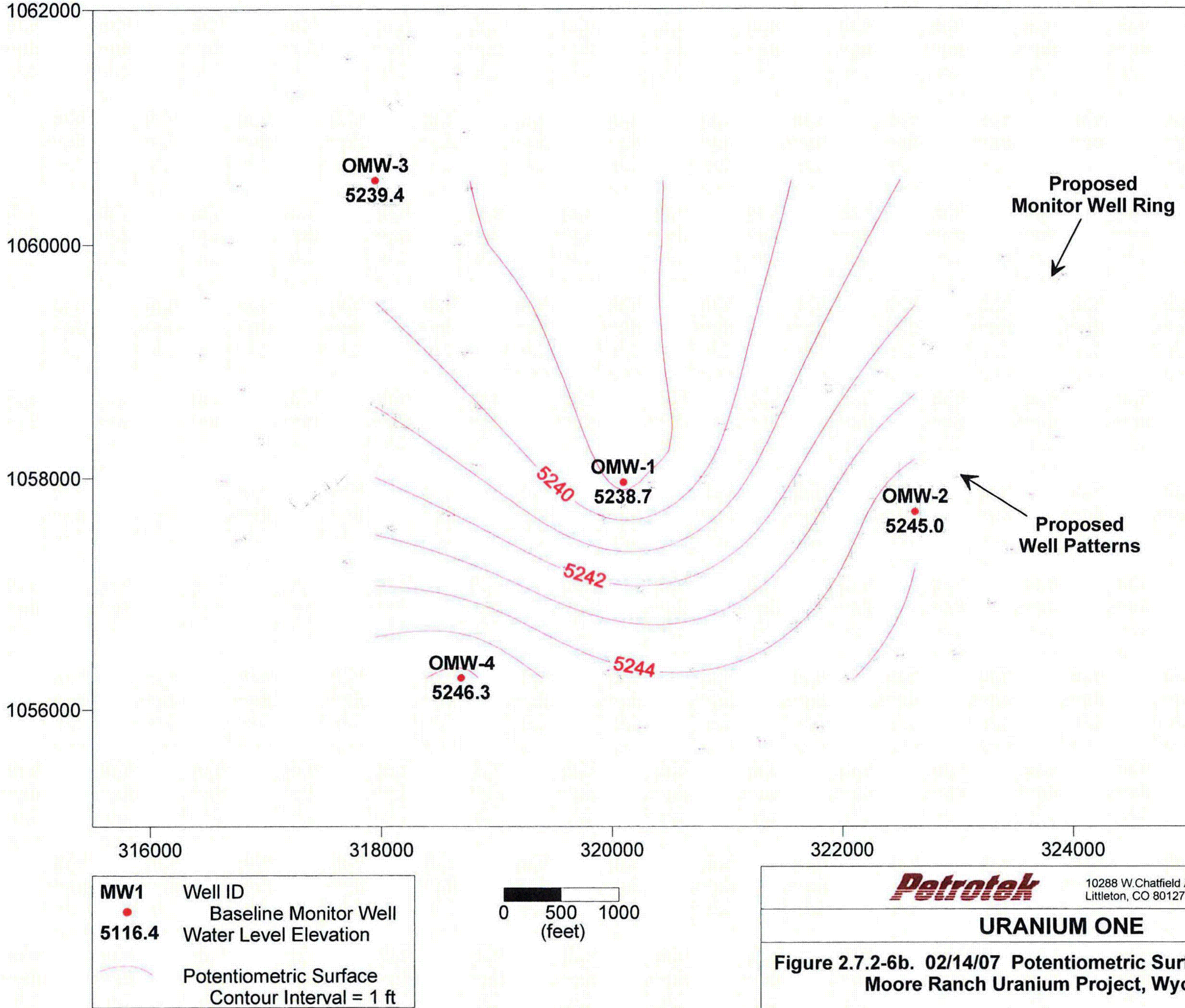


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Figure 2.7.2-6b. 02/14/07 Potentiometric Surface, 72 Sand Moore Ranch Uranium Project, Wyoming

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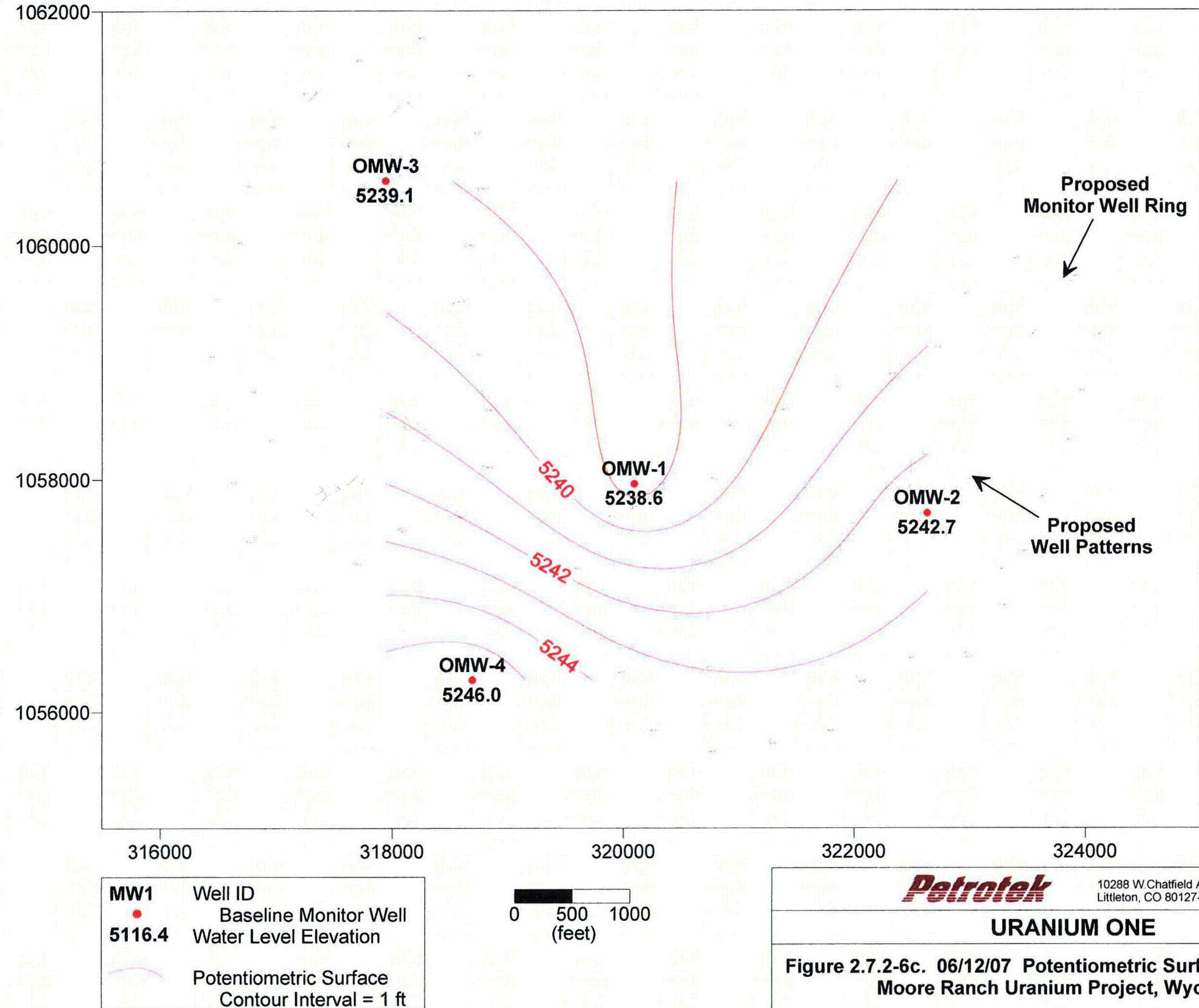

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Figure 2.7.2-6c. 06/12/07 Potentiometric Surface, 72 Sand
Moore Ranch Uranium Project, Wyoming

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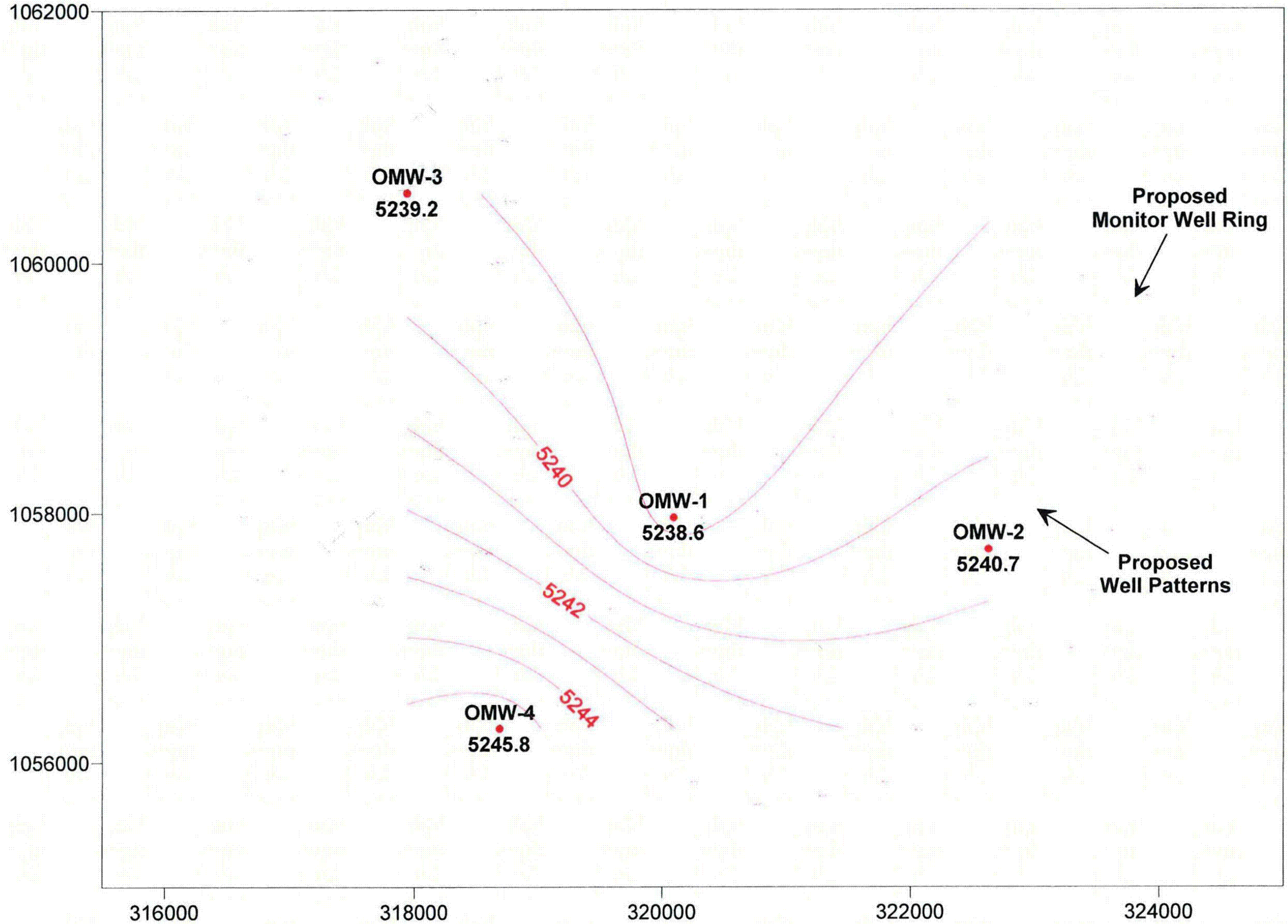

MW1	Well ID
●	Baseline Monitor Well
5116.4	Water Level Elevation
	Potentiometric Surface Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-6d. 07/17/07 Potentiometric Surface, 72 Sand
Moore Ranch Uranium Project, Wyoming

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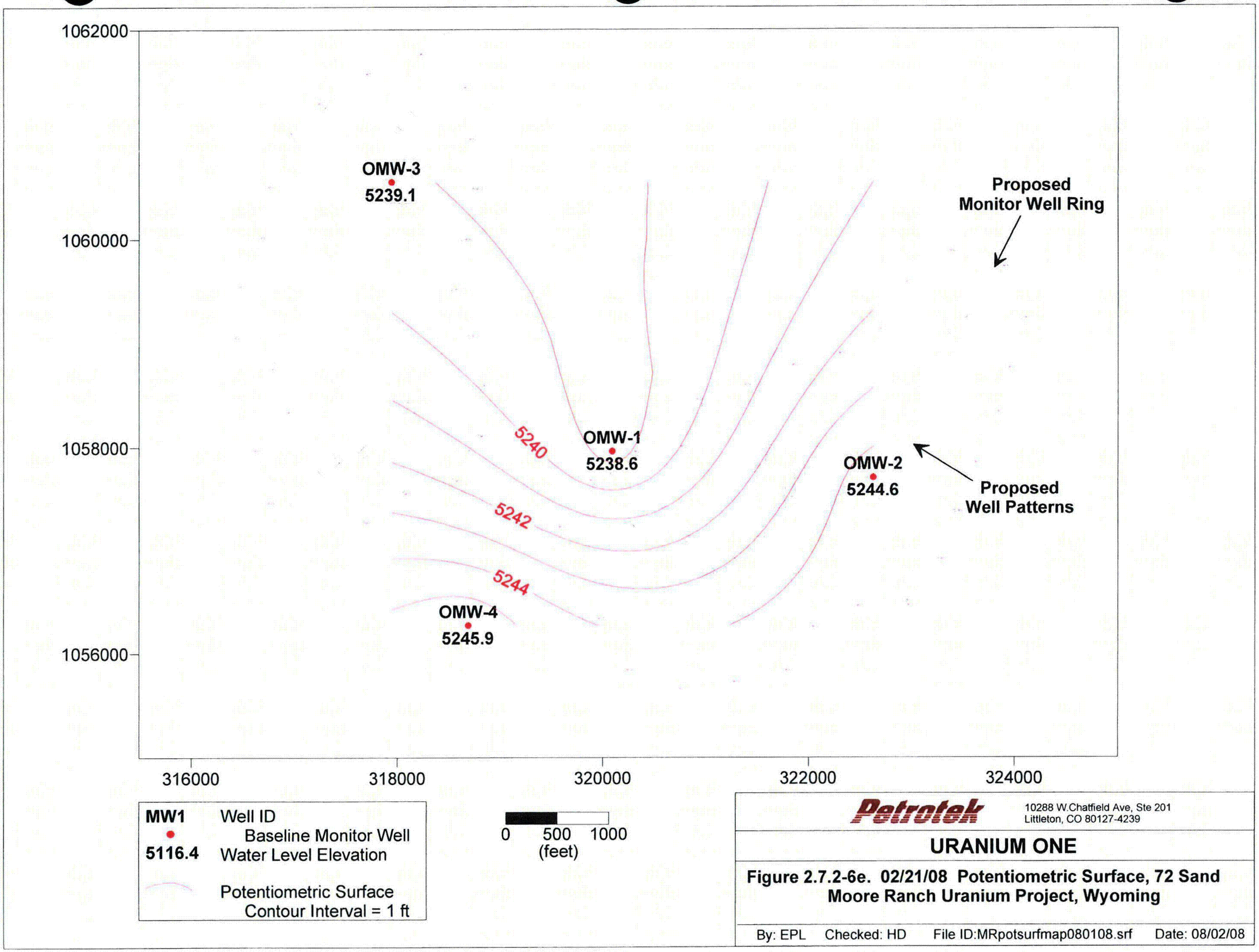

Figure 2.7.2-6e. 02/21/08 Potentiometric Surface, 72 Sand
Moore Ranch Uranium Project, Wyoming

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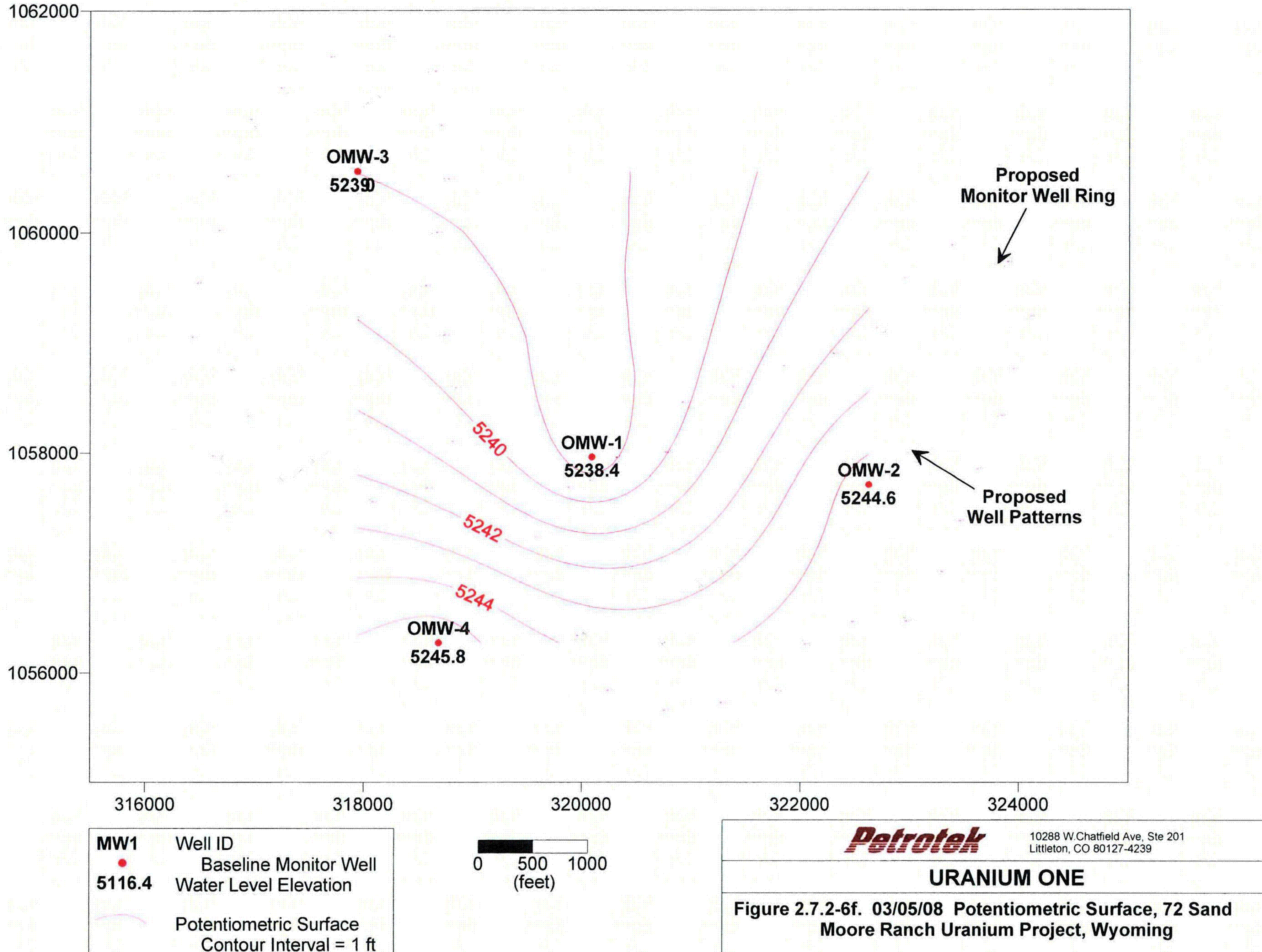

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Figure 2.7.2-6f. 03/05/08 Potentiometric Surface, 72 Sand Moore Ranch Uranium Project, Wyoming

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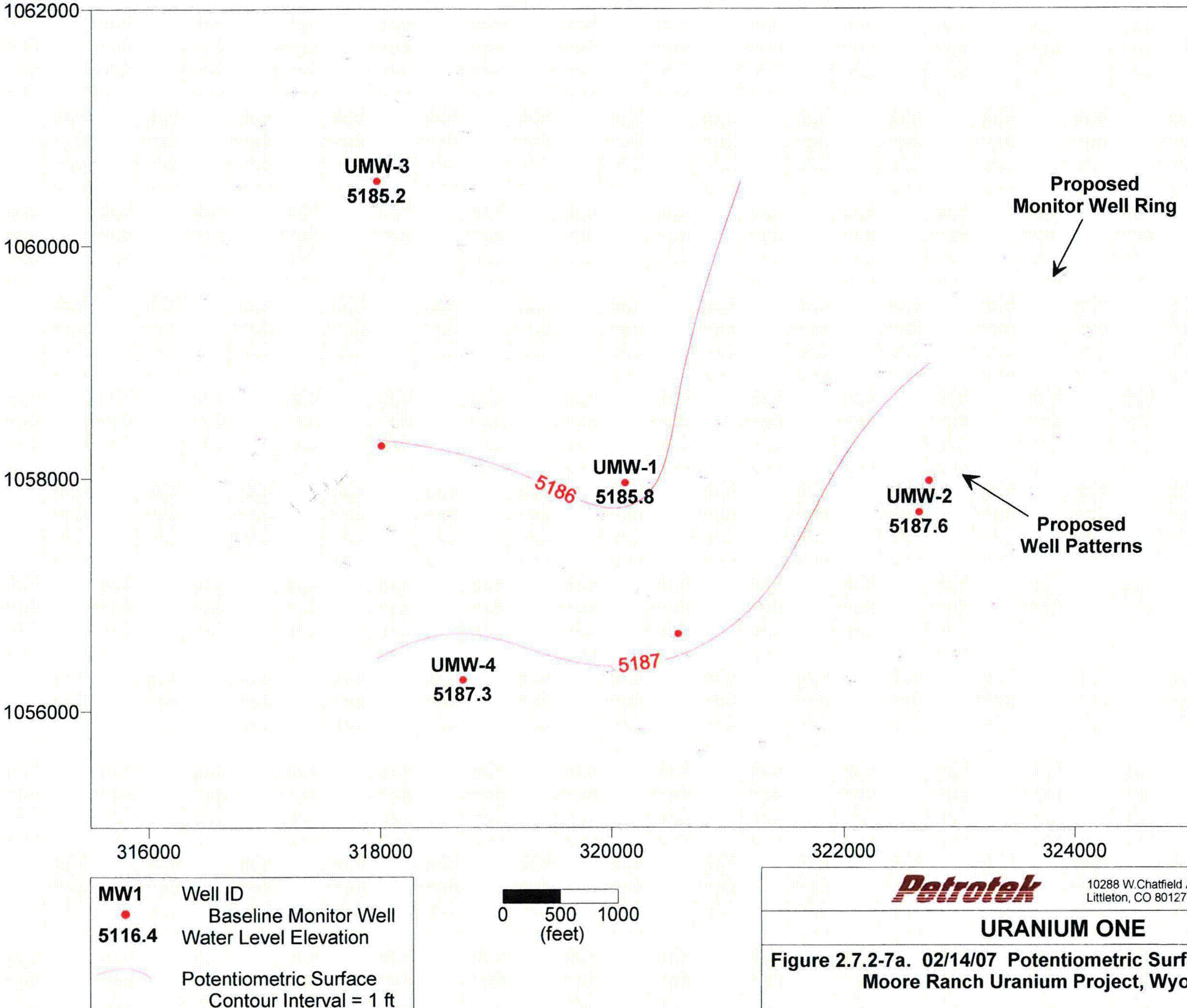

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Figure 2.7.2-7a. 02/14/07 Potentiometric Surface, 68 Sand
Moore Ranch Uranium Project, Wyoming

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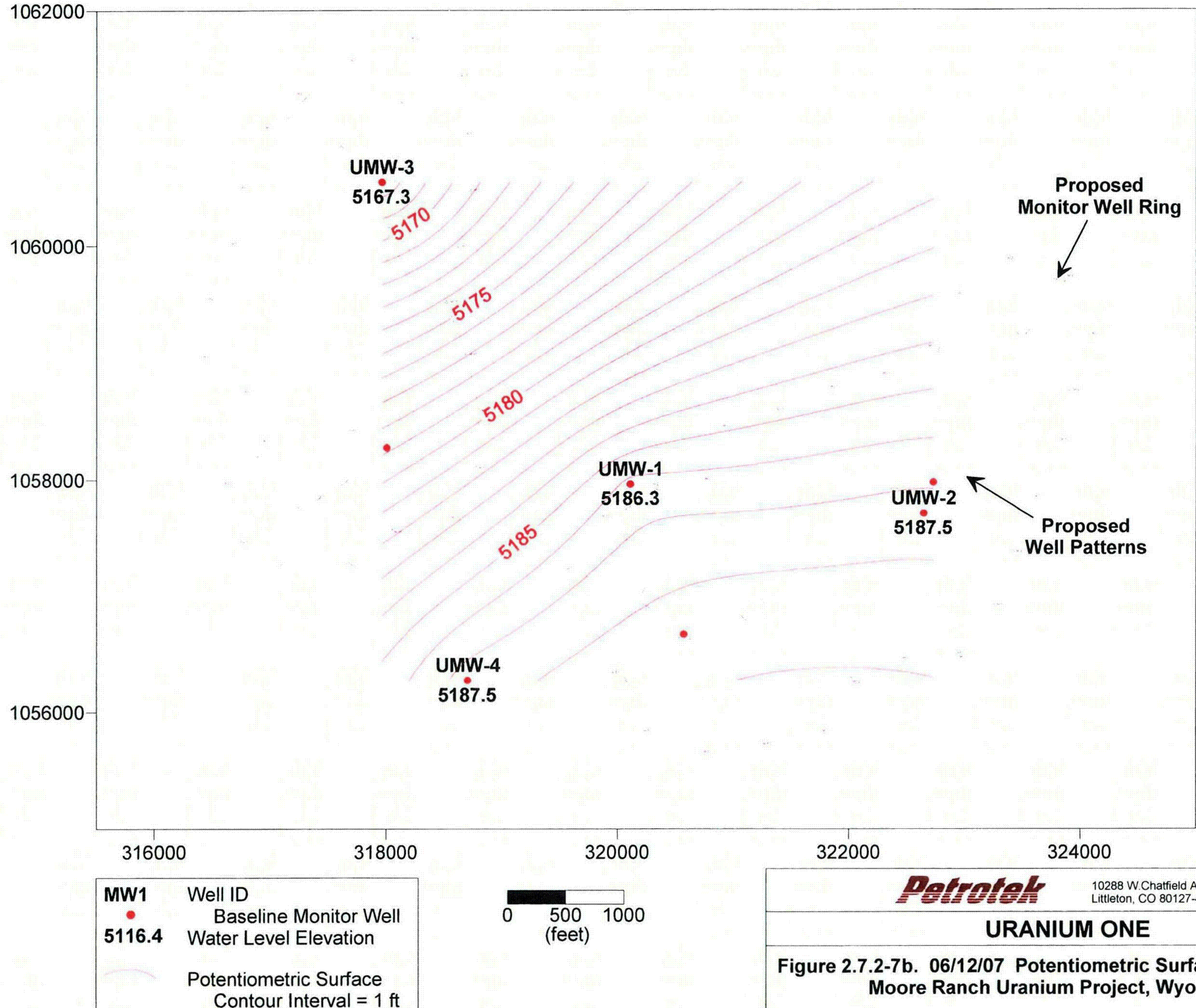

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Figure 2.7.2-7b. 06/12/07 Potentiometric Surface, 68 Sand Moore Ranch Uranium Project, Wyoming

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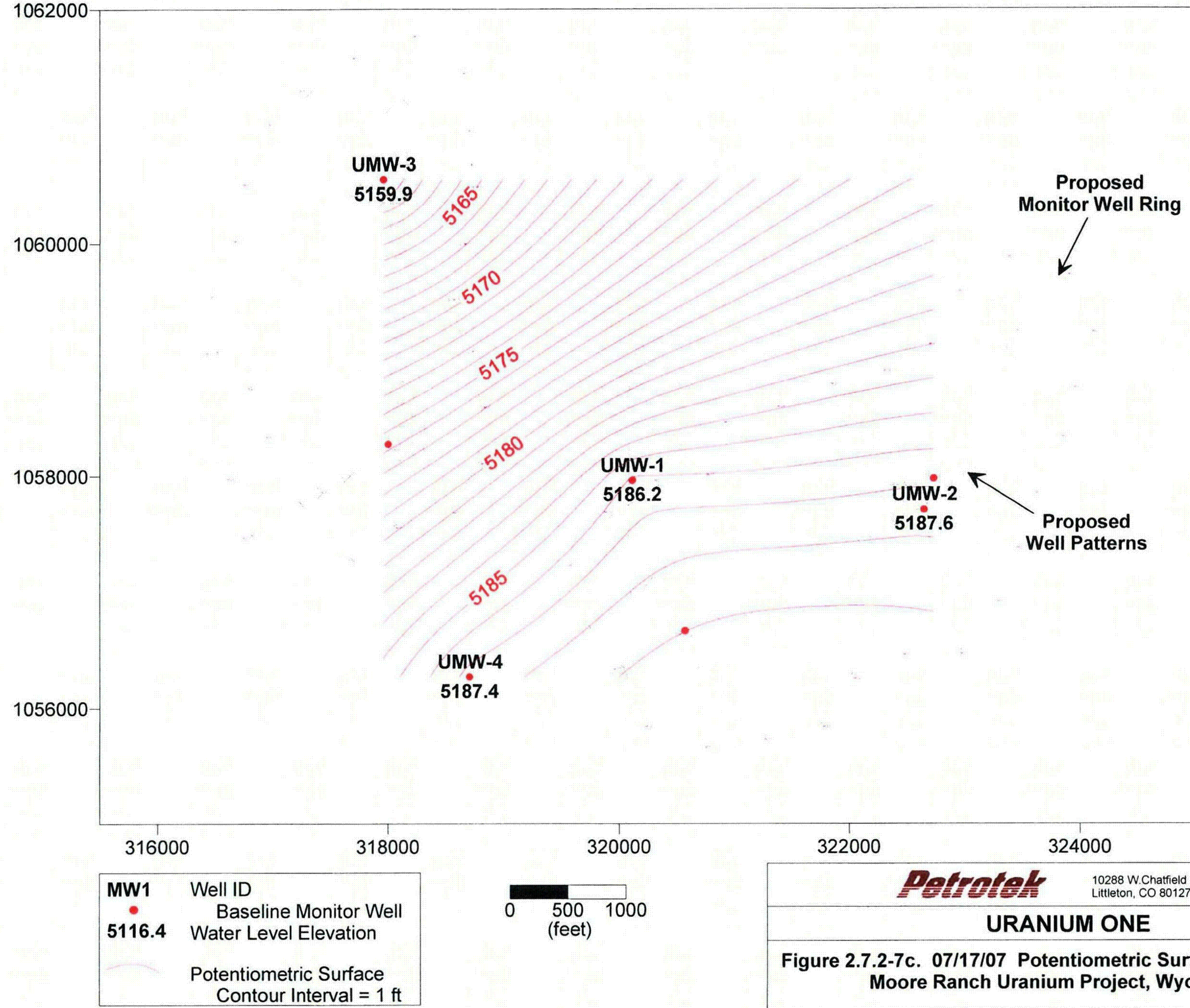

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Figure 2.7.2-7c. 07/17/07 Potentiometric Surface, 68 Sand Moore Ranch Uranium Project, Wyoming

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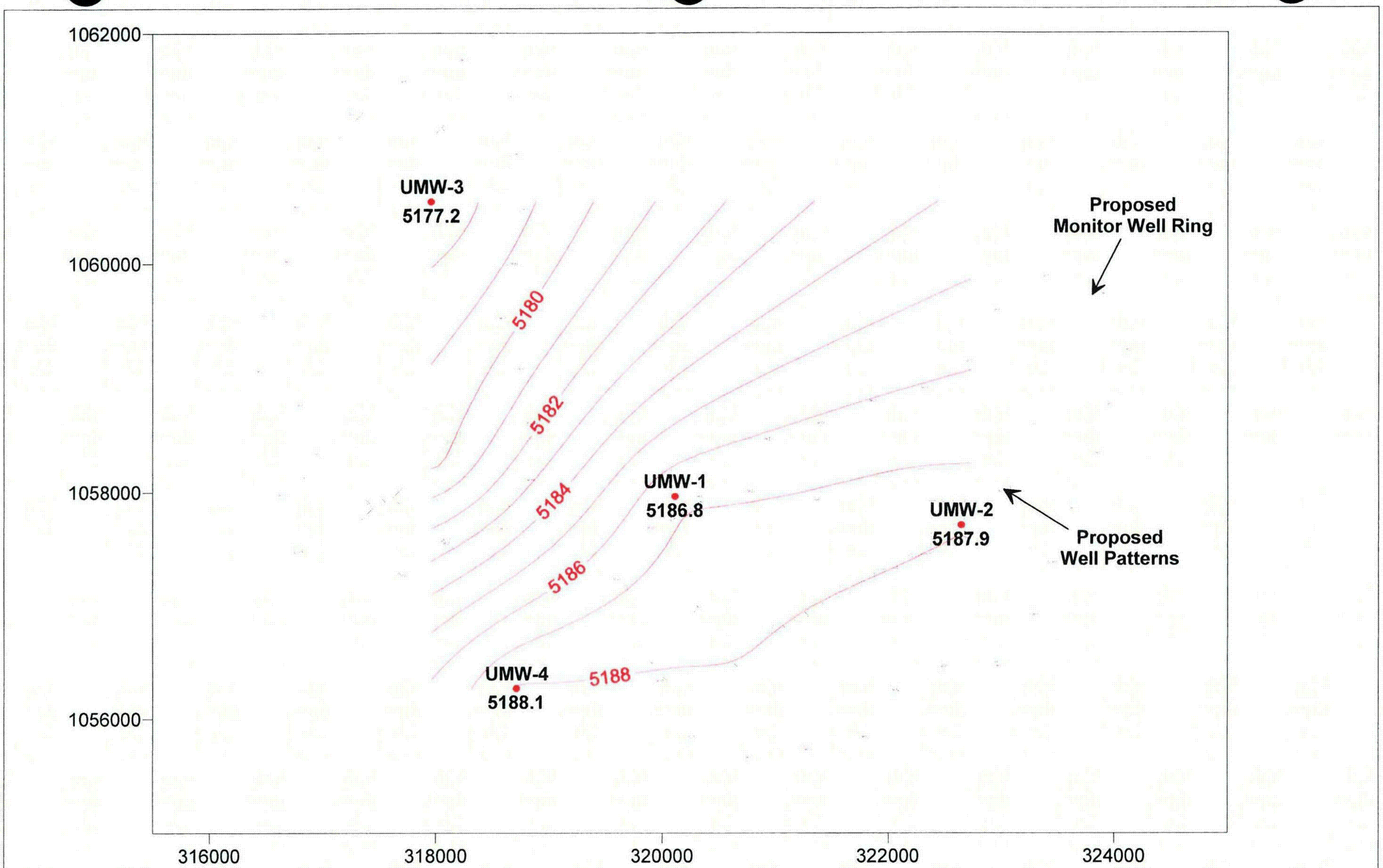

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Figure 2.7.2-7d. 02/21/08 Potentiometric Surface, 68 Sand
Moore Ranch Uranium Project, Wyoming

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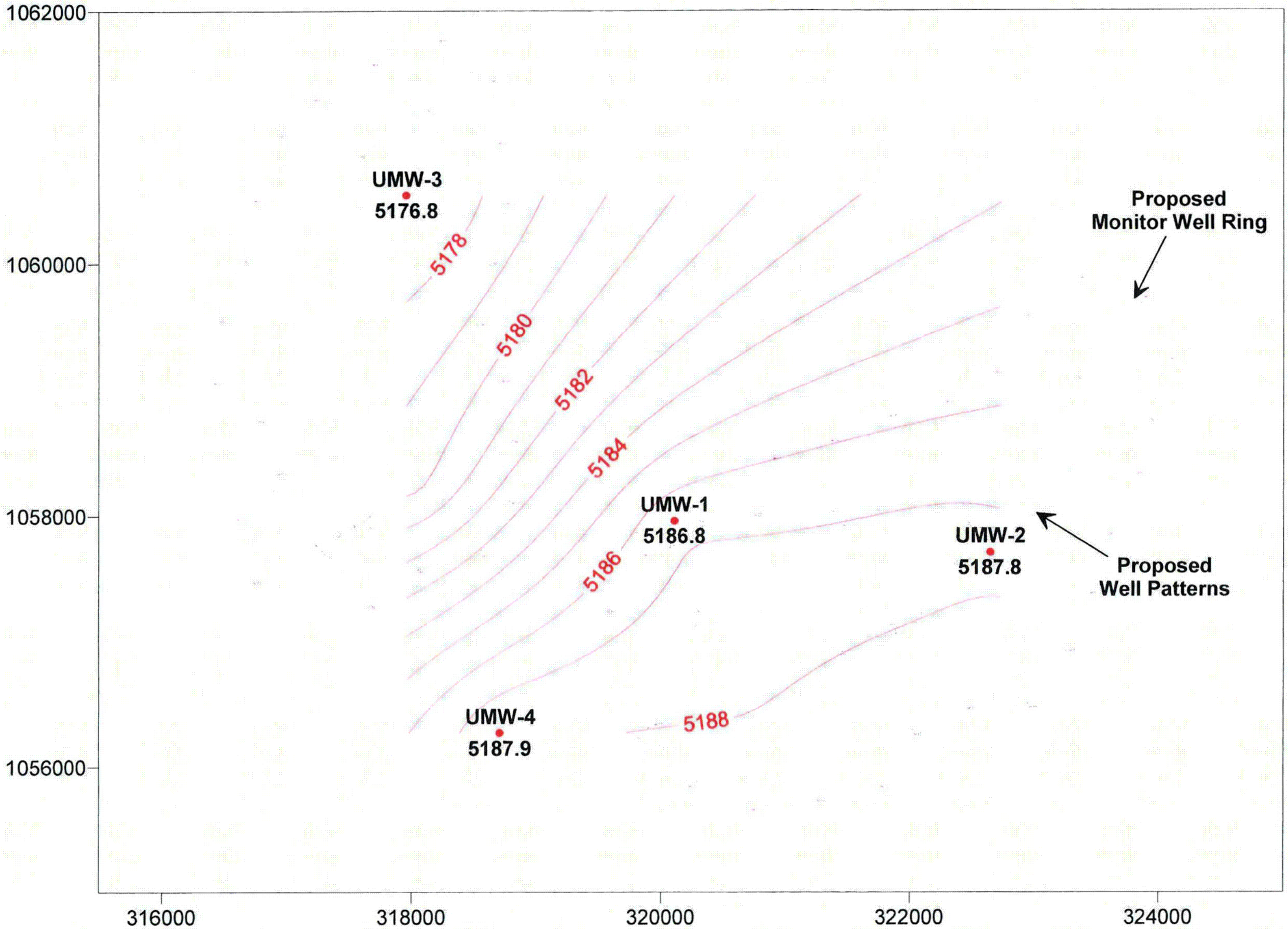

MW1 Well ID
Baseline Monitor Well
5116.4 Water Level Elevation
Potentiometric Surface
Contour Interval = 1 ft

0 500 1000
(feet)

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Figure 2.7.2-7e. 03/05/08 Potentiometric Surface, 68 Sand
Moore Ranch Uranium Project, Wyoming

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Figure 2.7.2-7f Hydrographs of 68 Sand Baseline Wells, Moore Ranch, Wyoming

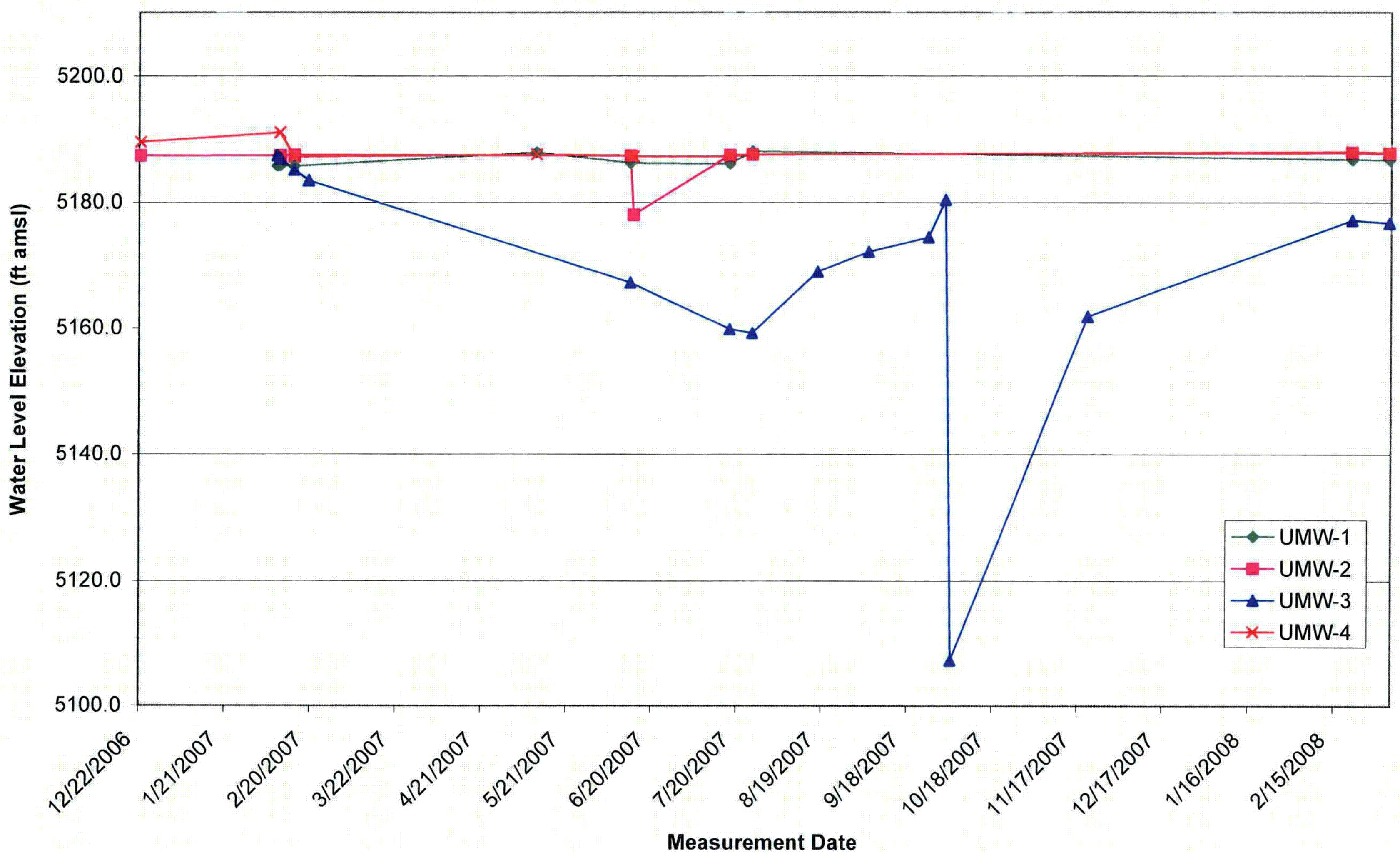


Figure 2.7.2-7g Hydrographs of Baseline Wells MW1 and UMW1, Moore Ranch, Wyoming

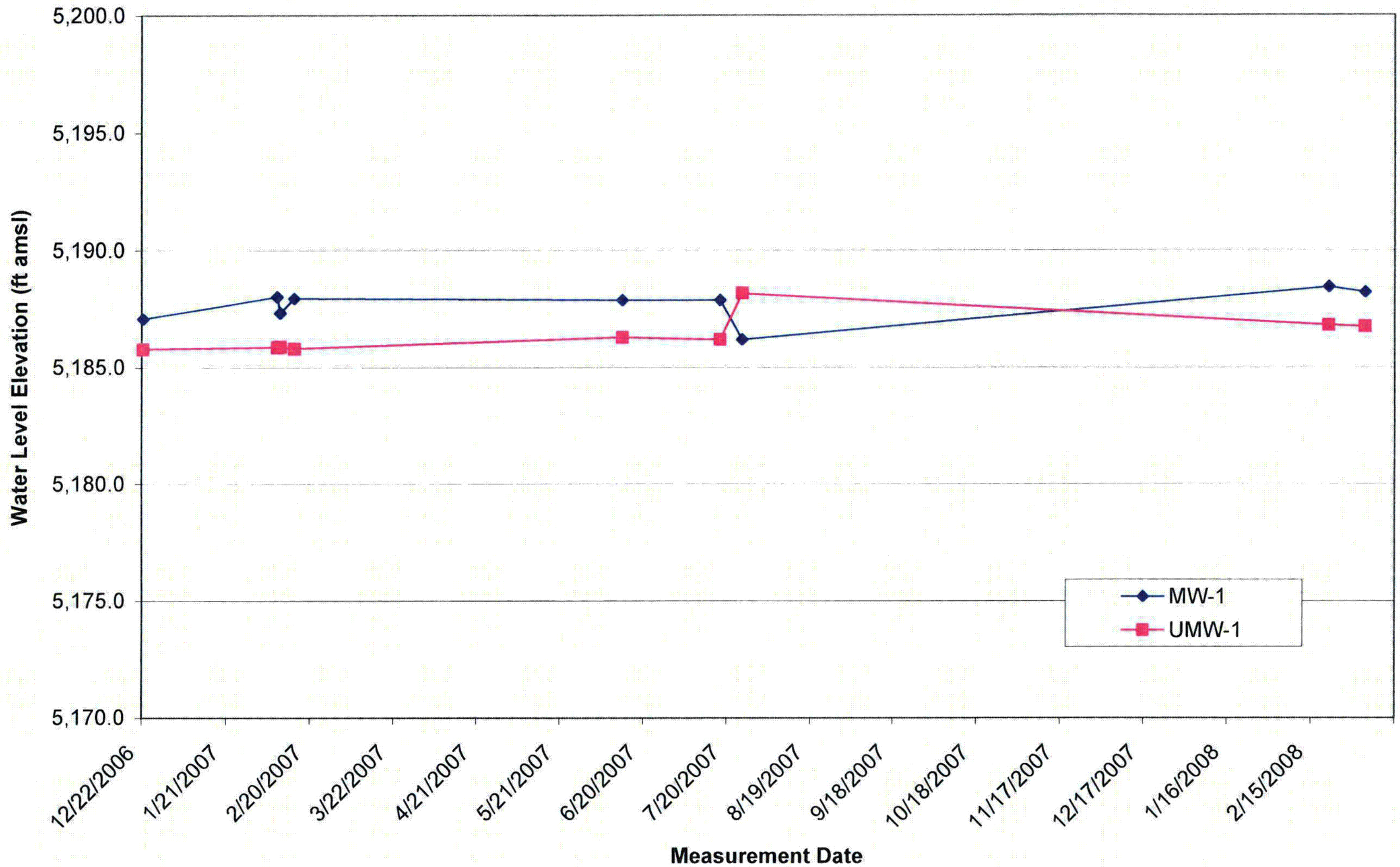


Figure 2.7.2-7h Hydrographs of Baseline Wells MW2 and UMW2, Moore Ranch, Wyoming

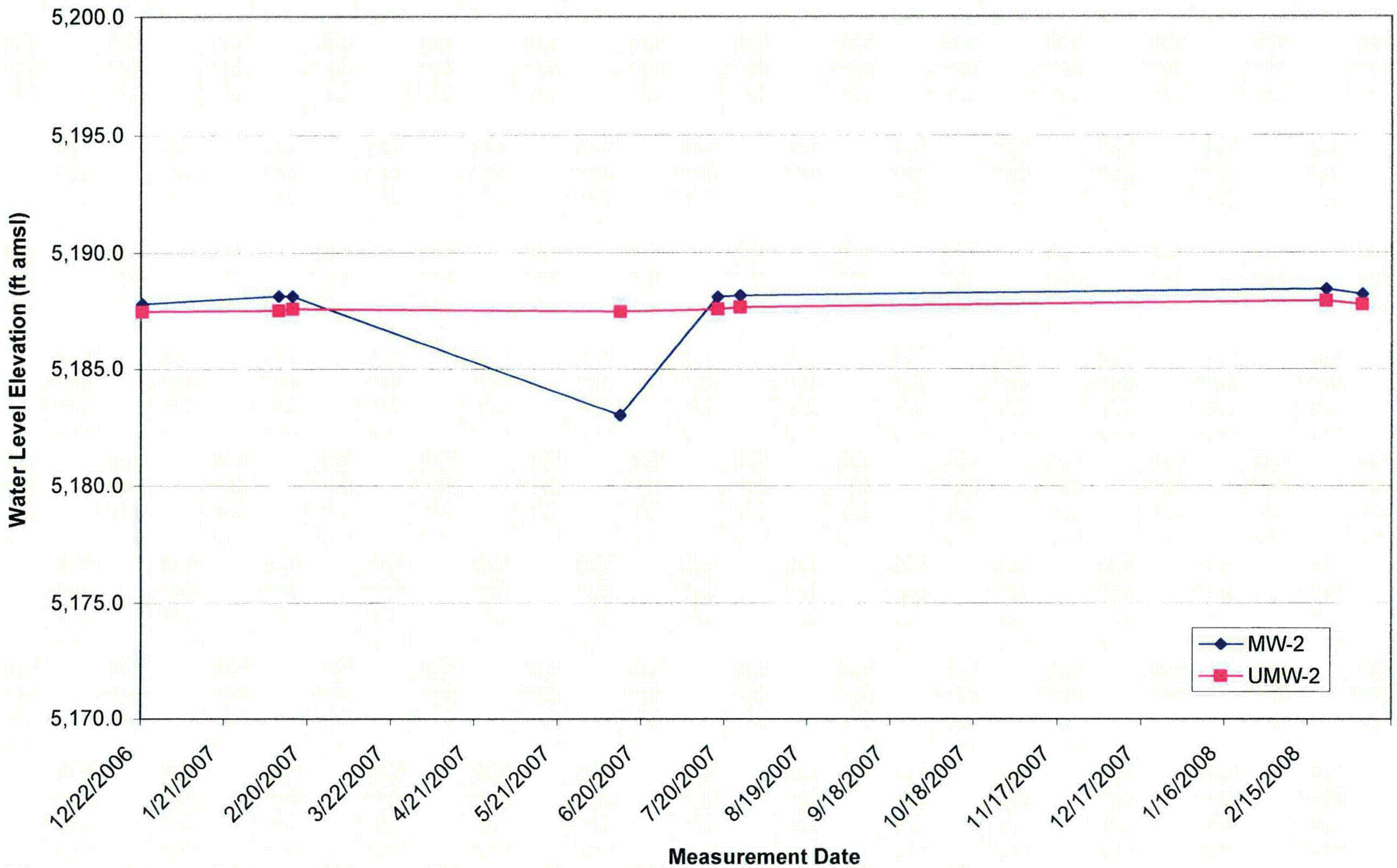


Figure 2.7.2-7i Hydrographs of Baseline Wells MW3 and UMW3, Moore Ranch, Wyoming

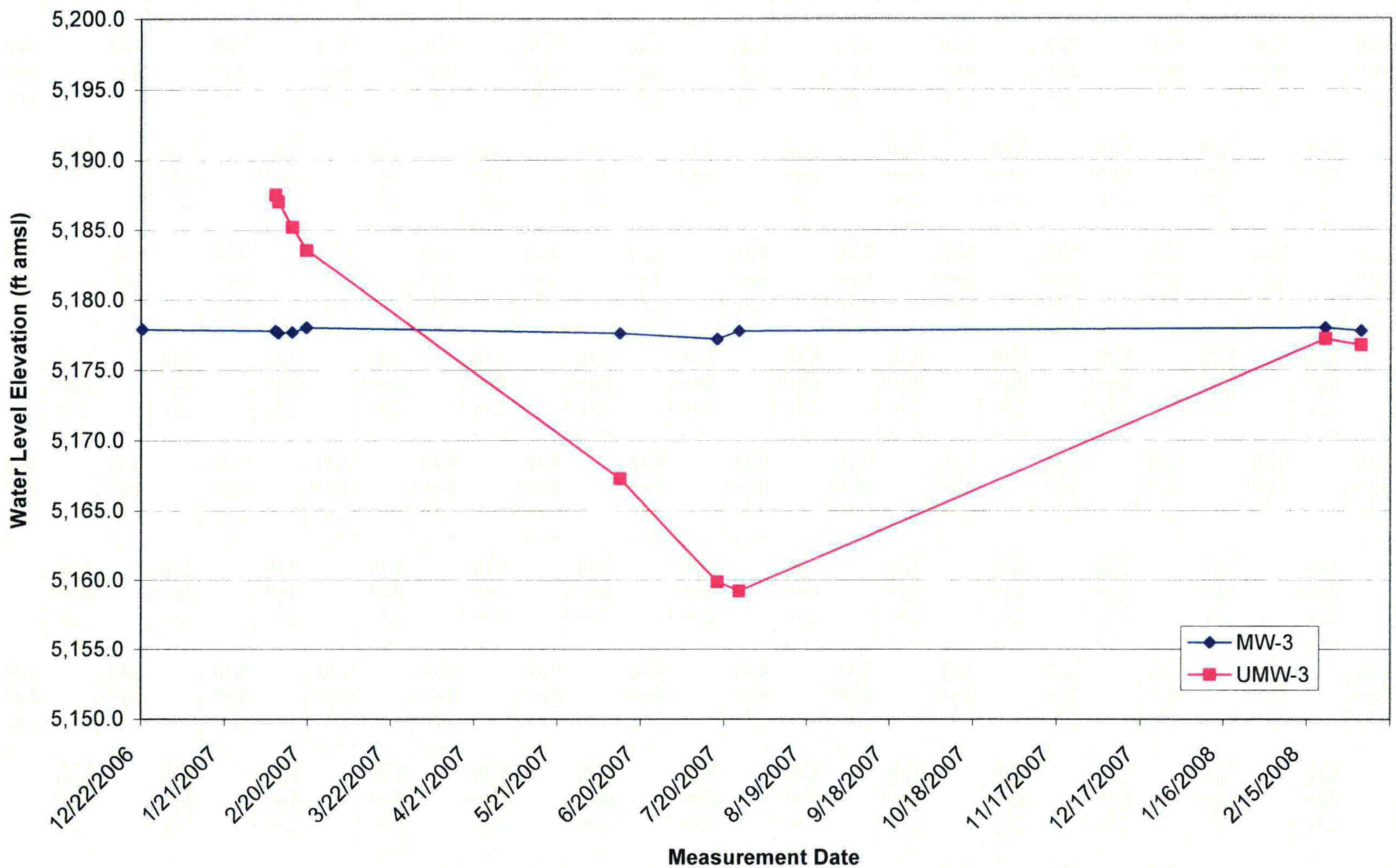


Figure 2.7.2-7j Hydrographs of Baseline Wells MW4 and UM4, Moore Ranch, Wyoming

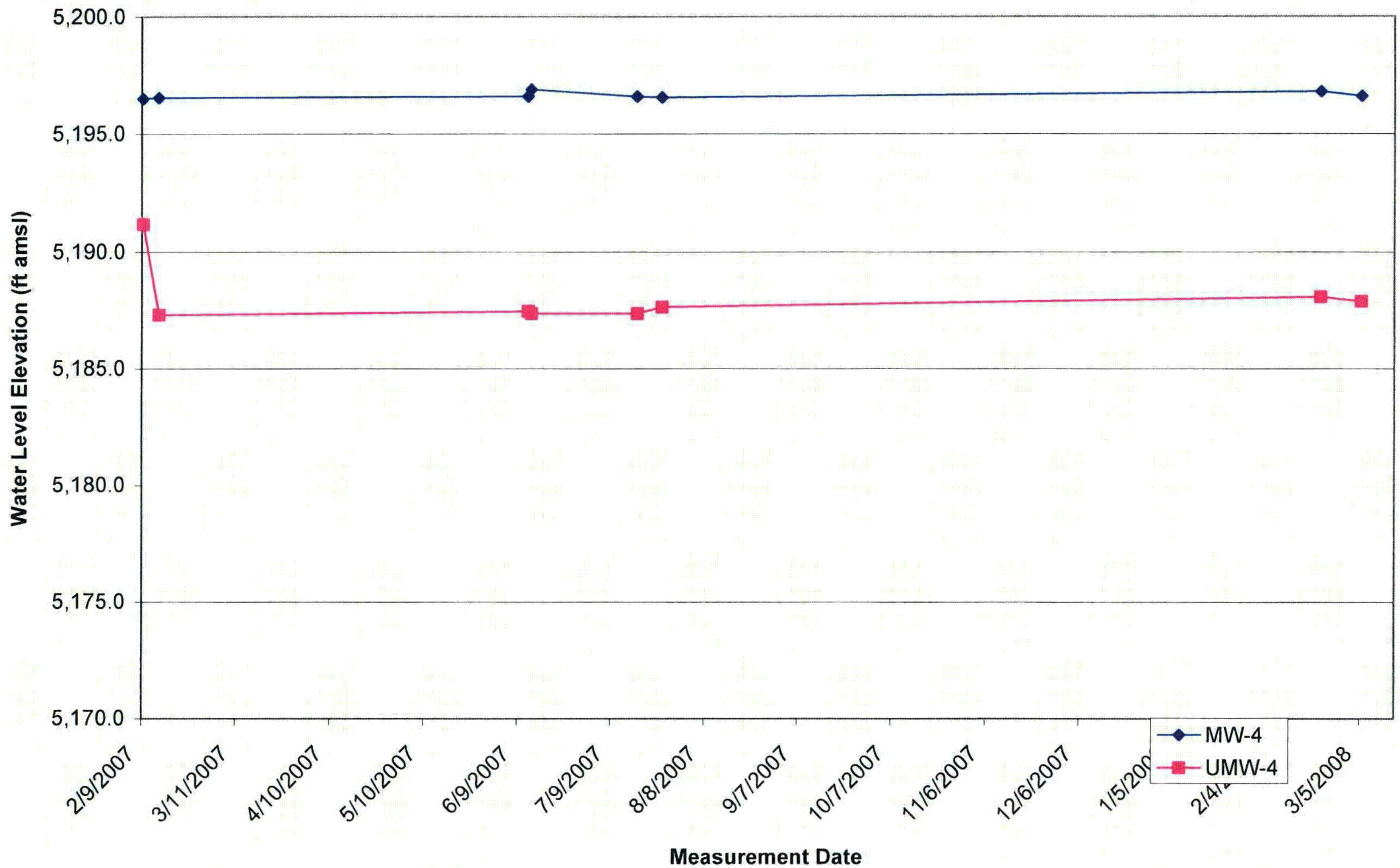


Figure 2.7.2-7k Hydrograph of 68 Sand Monitor Well UMW3, Moore Ranch, Wyoming

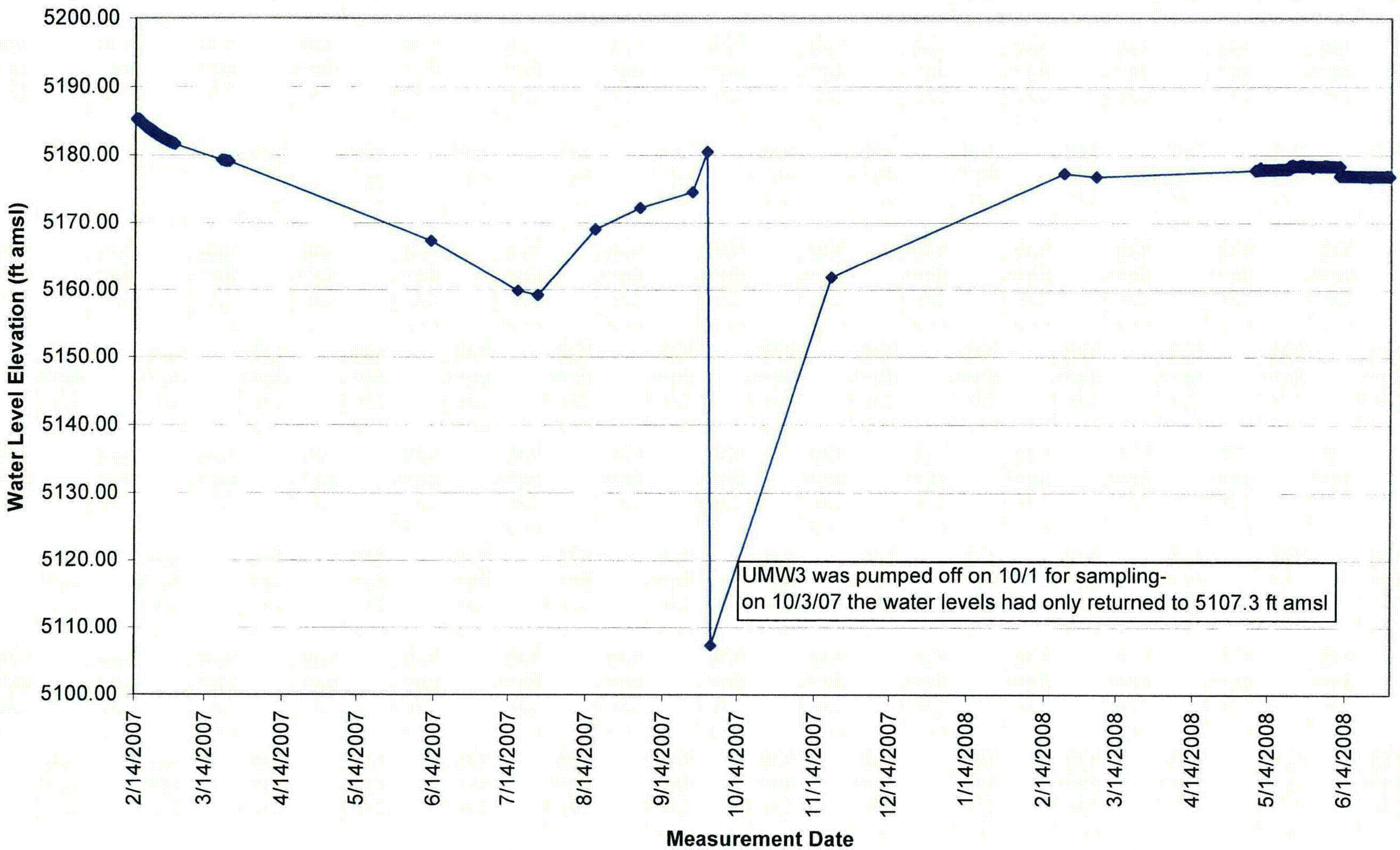


Figure 2.7.2-11a Hydrographs of Baseline Wells MW1 and OMW1, Moore Ranch, Wyoming

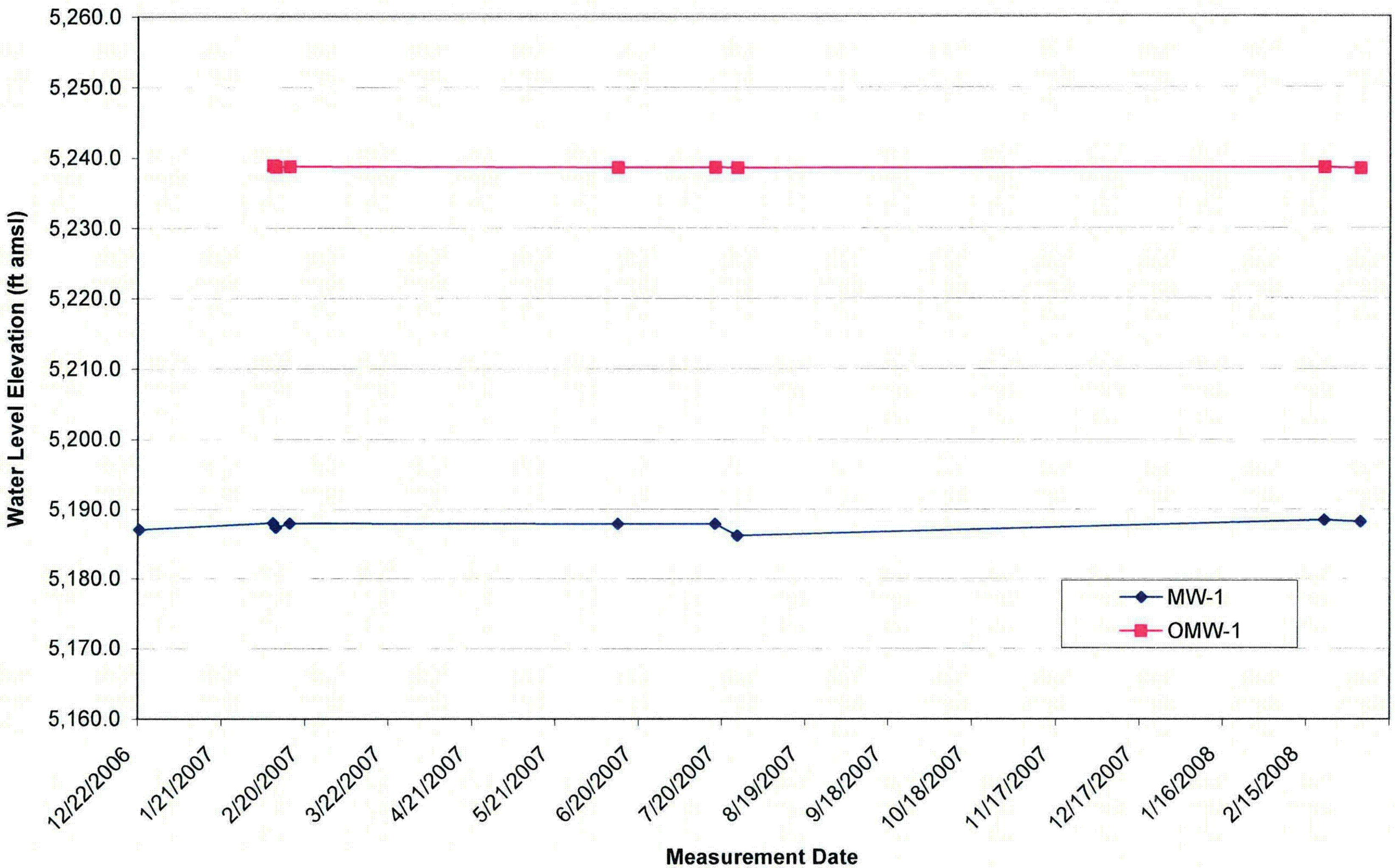


Figure 2.7.2-11b Hydrographs of Baseline Wells MW2 and OMW2, Moore Ranch, Wyoming

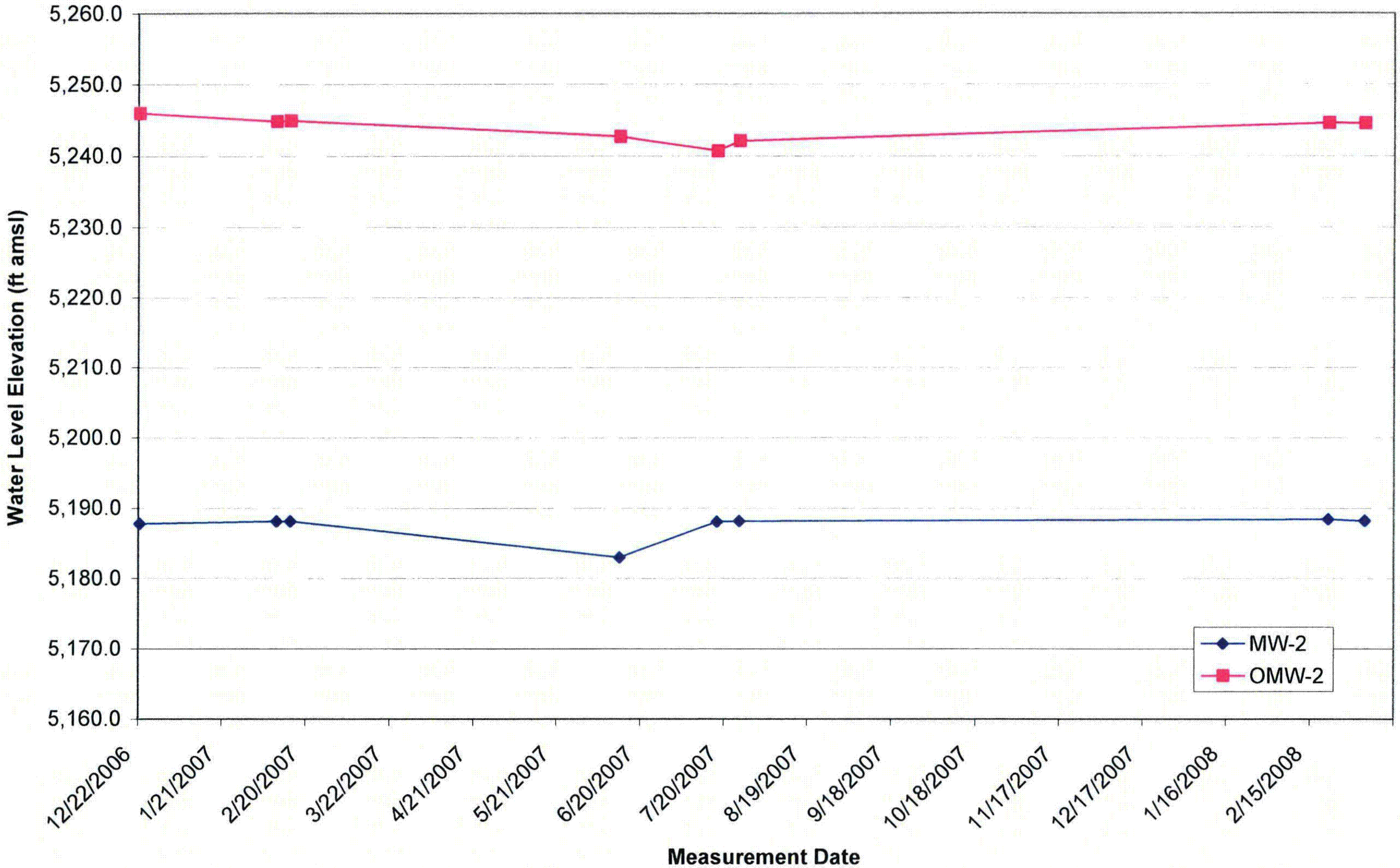


Figure 2.7.2-11c Hydrographs of Baseline Wells MW3 and OMW3, Moore Ranch, Wyoming

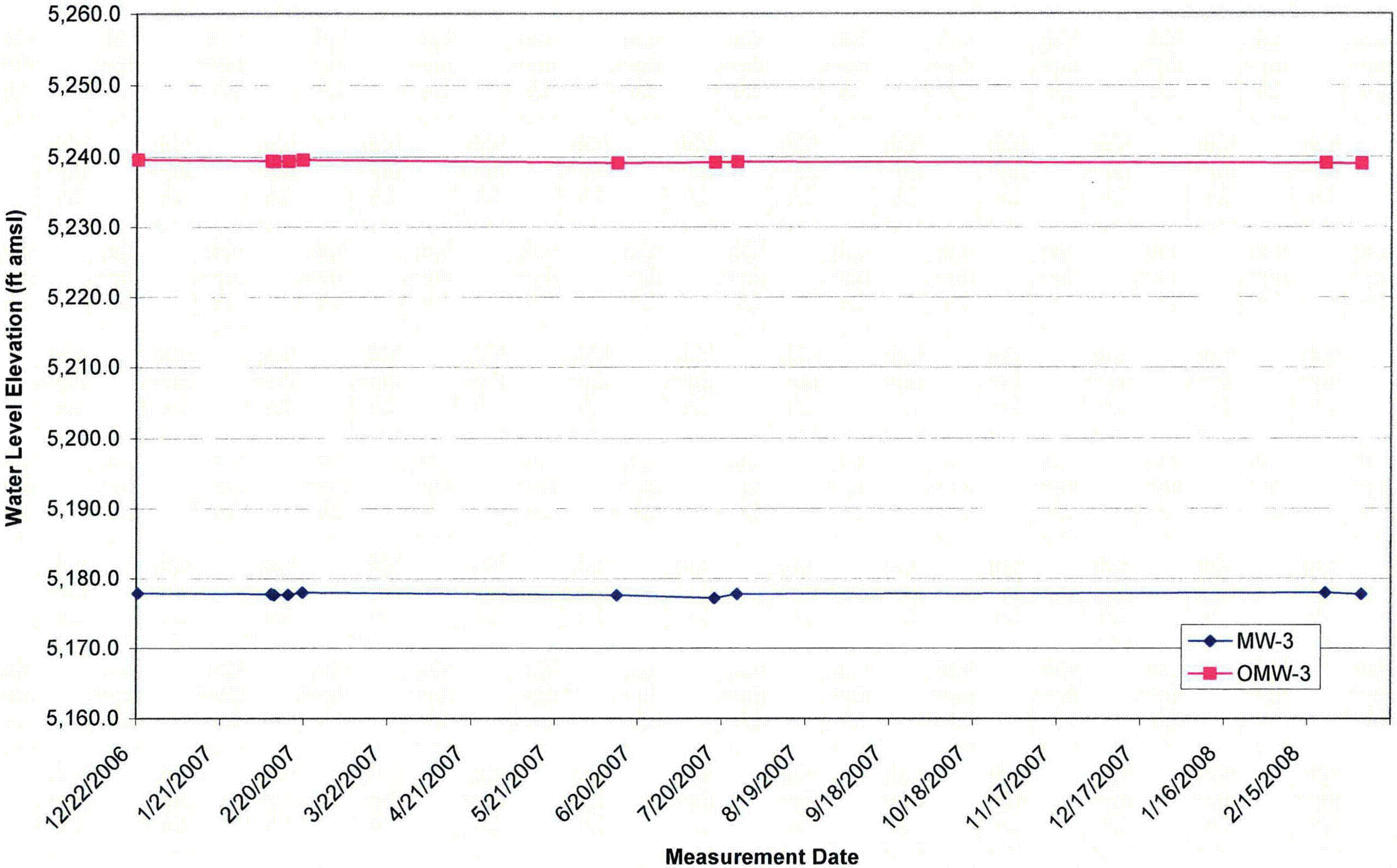
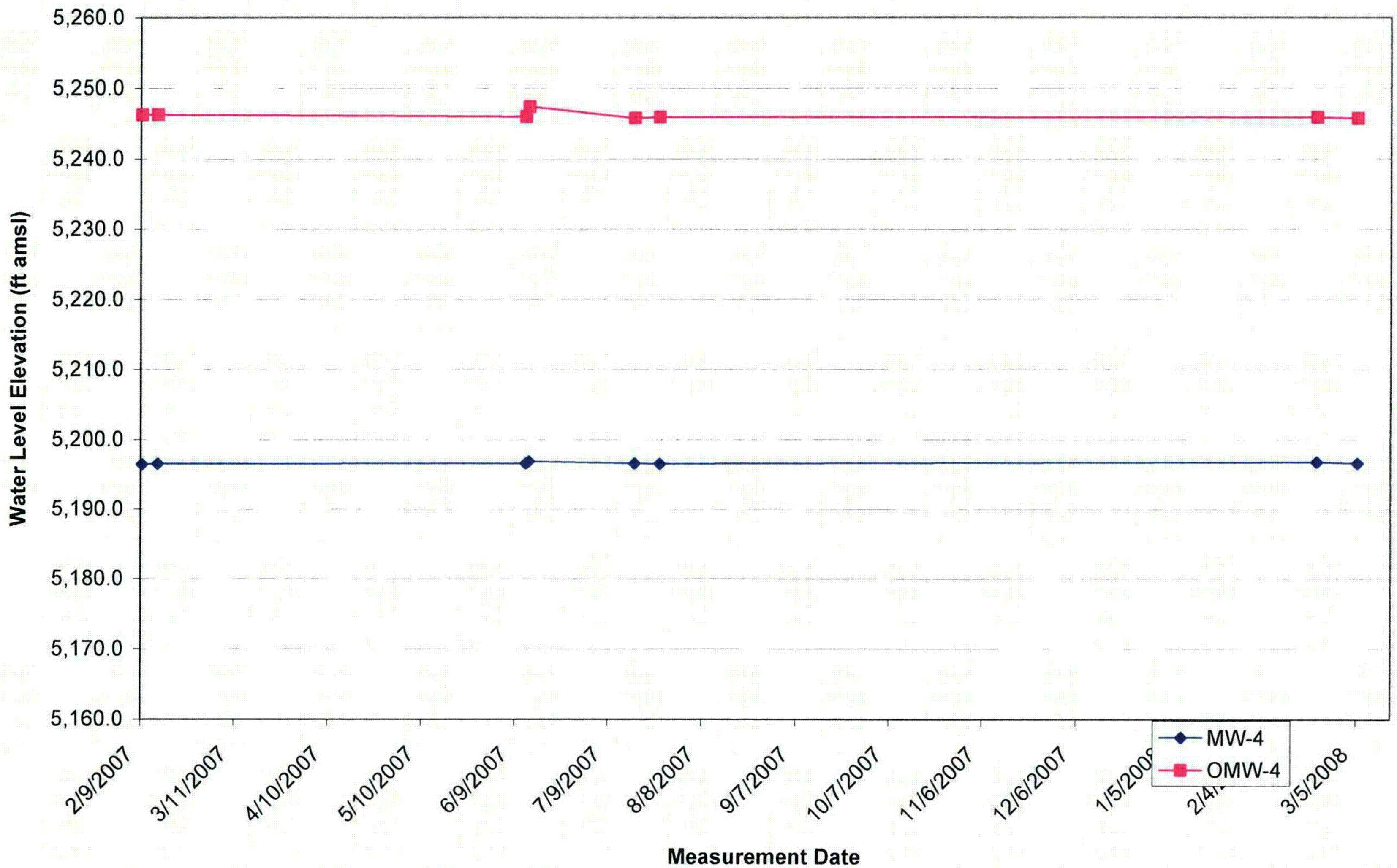
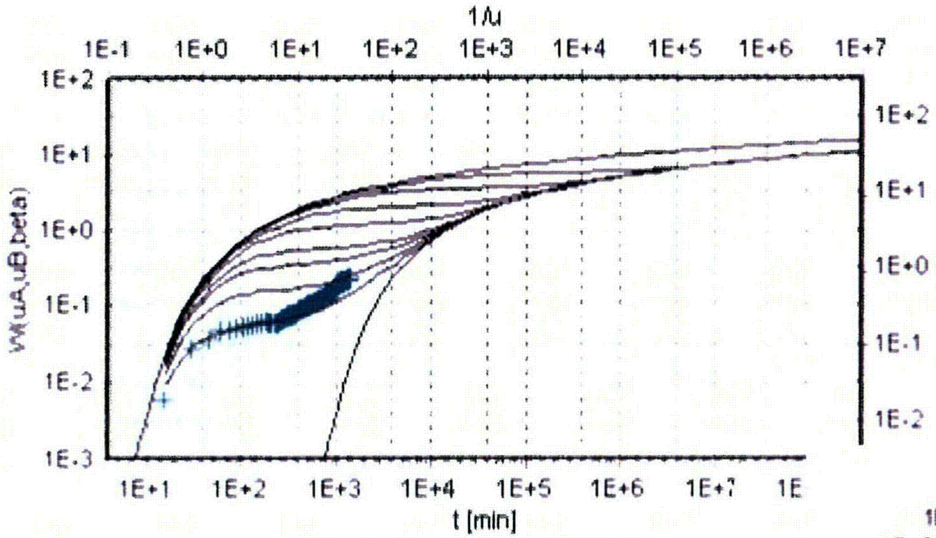


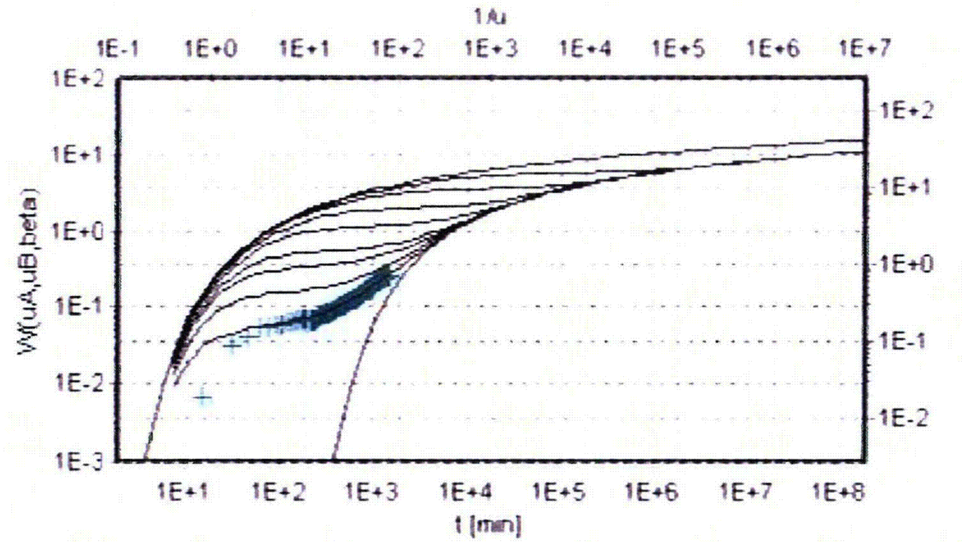
Figure 2.7.2-11d Hydrographs of Baseline Wells MW4 and OM4, Moore Ranch, Wyoming





Early Time Curve Match

Transmissivity: 1.26E+2 ft²/d
Conductivity: 1.66E+0 ft/d
Storativity: 1.10E-4
Specific Yield: 1.10E-2



Late Time Curve Match

Transmissivity: 1.45E+2 ft²/d
Conductivity: 1.90E+0 ft/d
Storativity: 5.92E-5
Specific Yield: 5.92E-3

Pumping Rate - 26.0 gpm
Pumping Duration Time - 1 day
Saturated Thickness = 76 feet
Distance to Pumping Well = 346 feet

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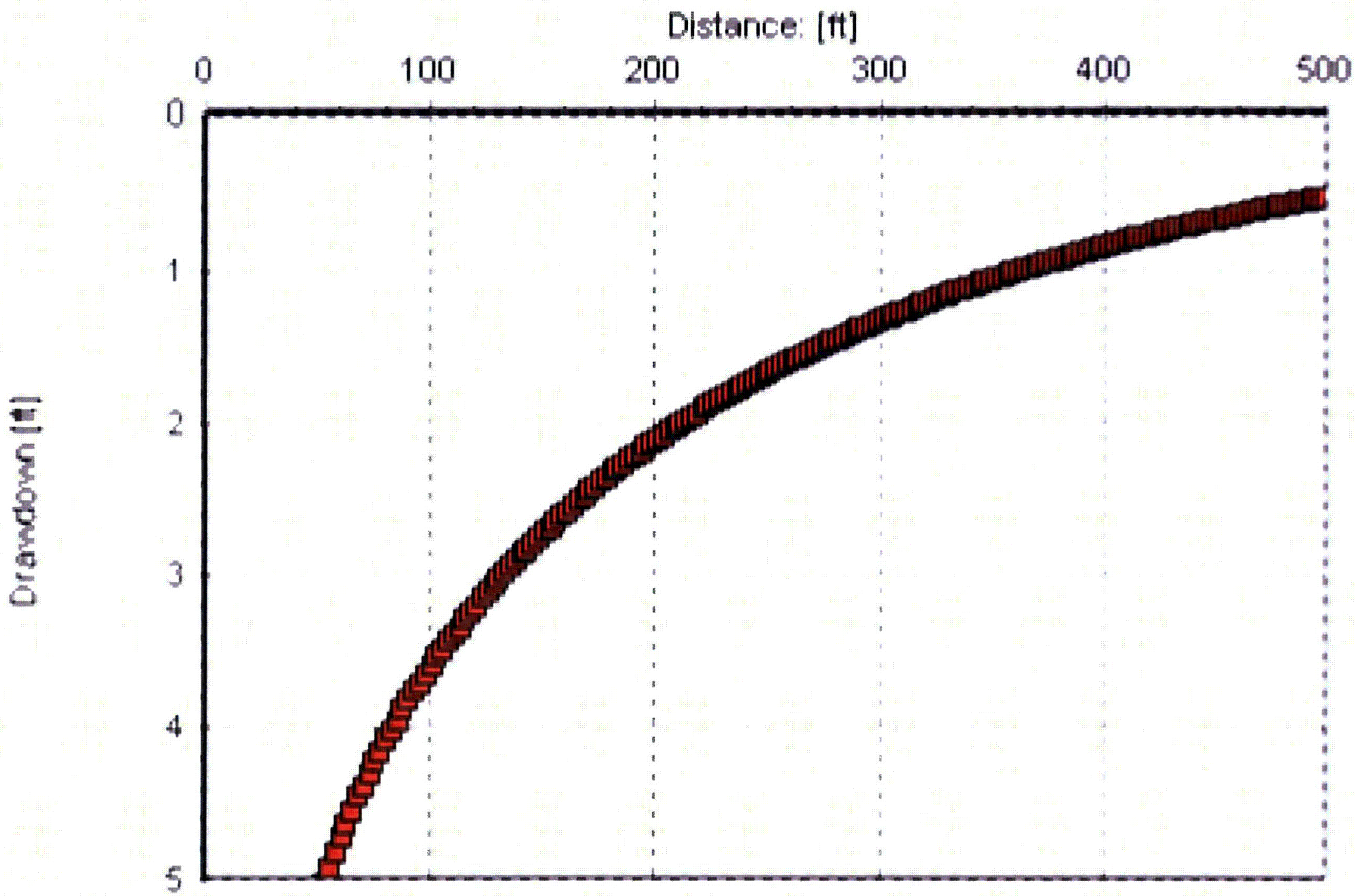
URANIUM ONE

Figure 2.7.2-12. Neuman Delayed Yield Analysis, Well 885
MW2 Pump Test 2007
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig26b1neuman885.srf Date: 08/02/08



Transmissivity - 300 ft2/d
Storativity (specific yield) - 0.028
Pumping Rate - 22 gpm
Time - 10 days

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URANIUM ONE

Figure 2.7.2-13. Predicted Drawdown vs Distance After 10 Days At 22 gpm Moore Ranch Uranium Project, Wyoming

By: EPL | Checked: HD | File ID:MRpotsurfmap080108.srf | Date: 08/02/08

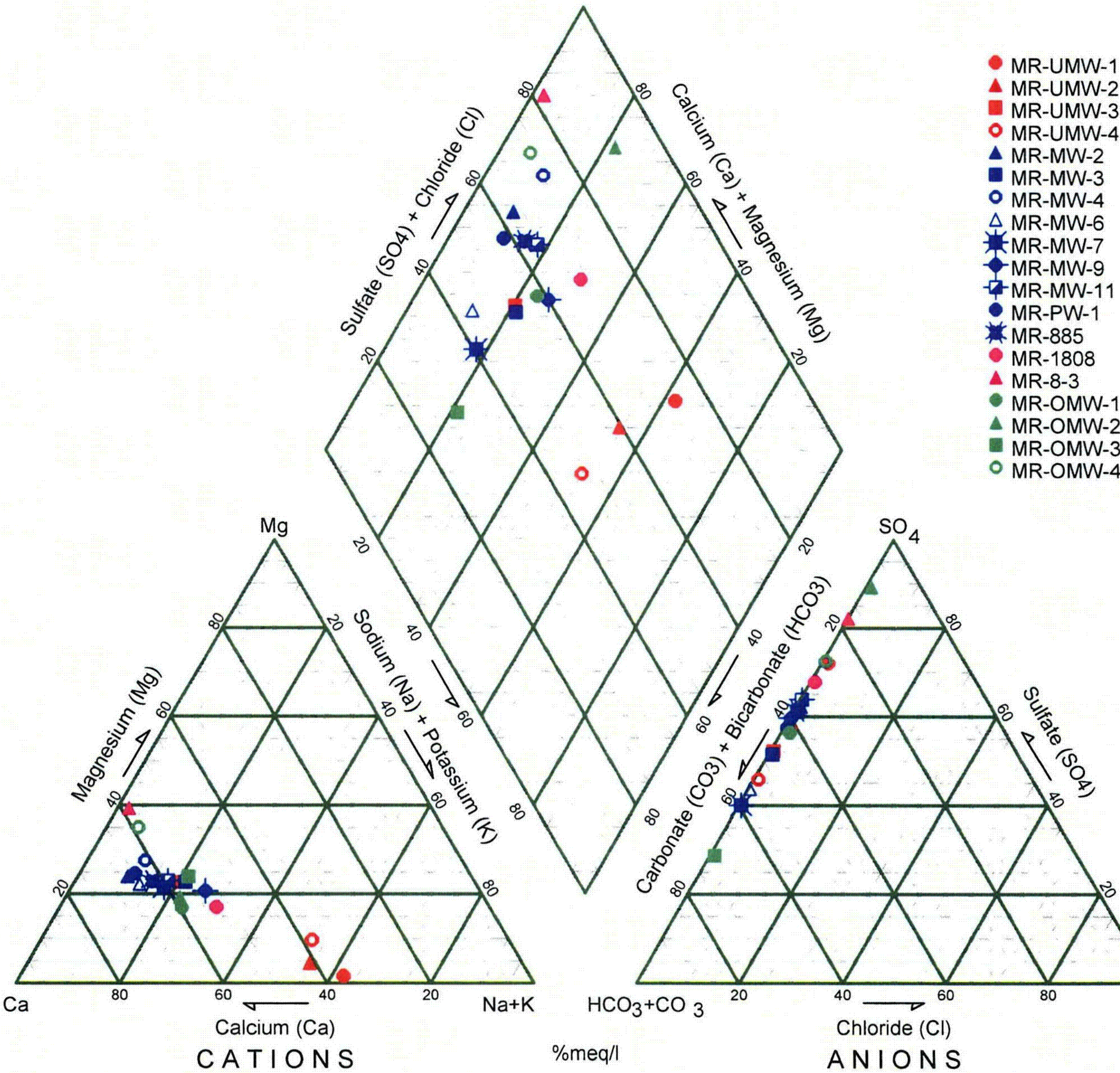

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Figure 2.7.3-3

Piper Diagram - Average Water Quality in Monitor Wells, Moore Ranch

Project: 312-07	Date: March 2008
Figure 2.7.3-3.ai	By: JLM / Checked: KC

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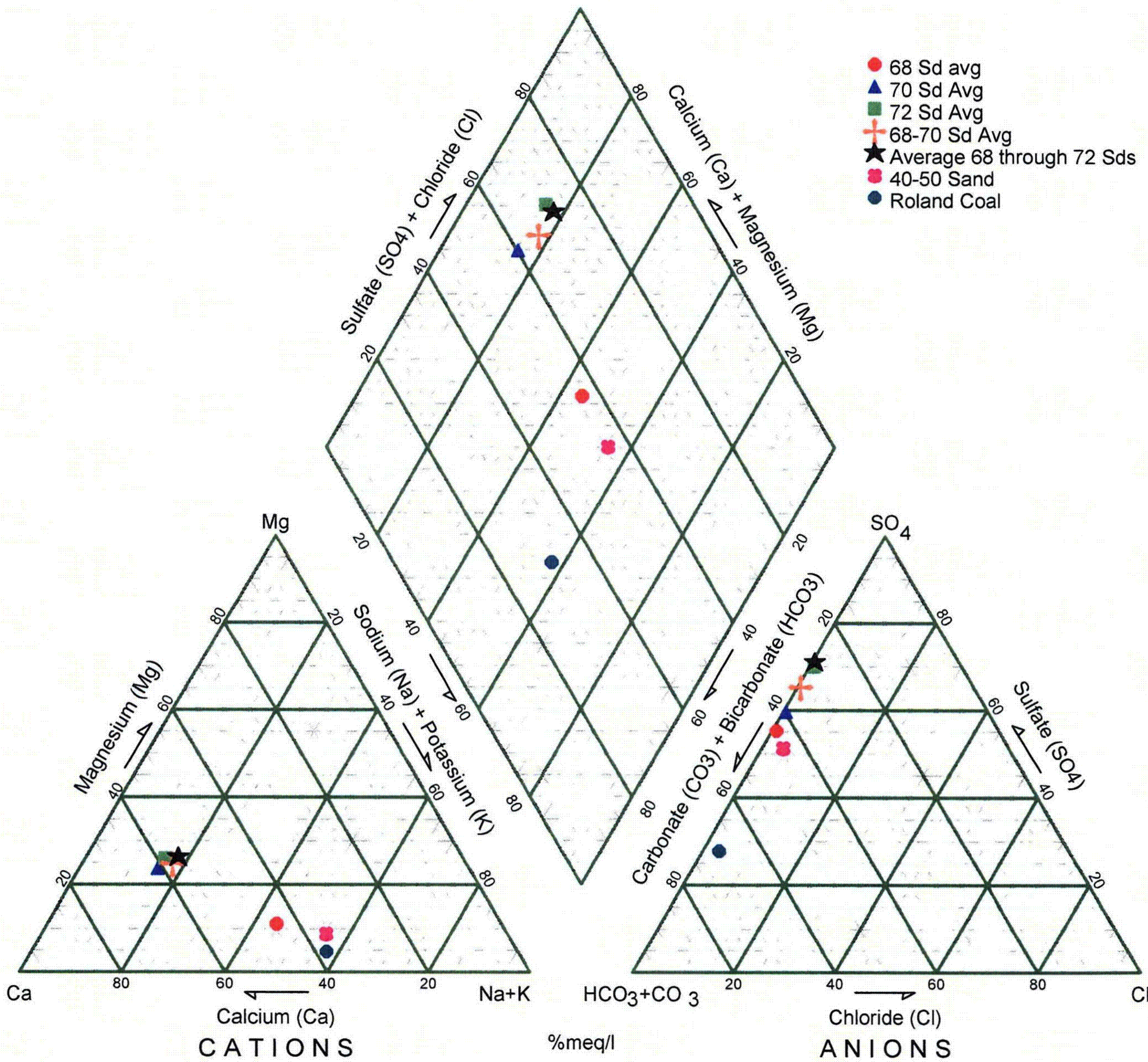

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Figure 2.7.3-4
Piper Diagram - Average Water Quality in Aquifers, Moore Ranch

Project: 312-07	Date: March 2008	
Figure 2.7.3-4.ai	By: JLM	Checked: KC

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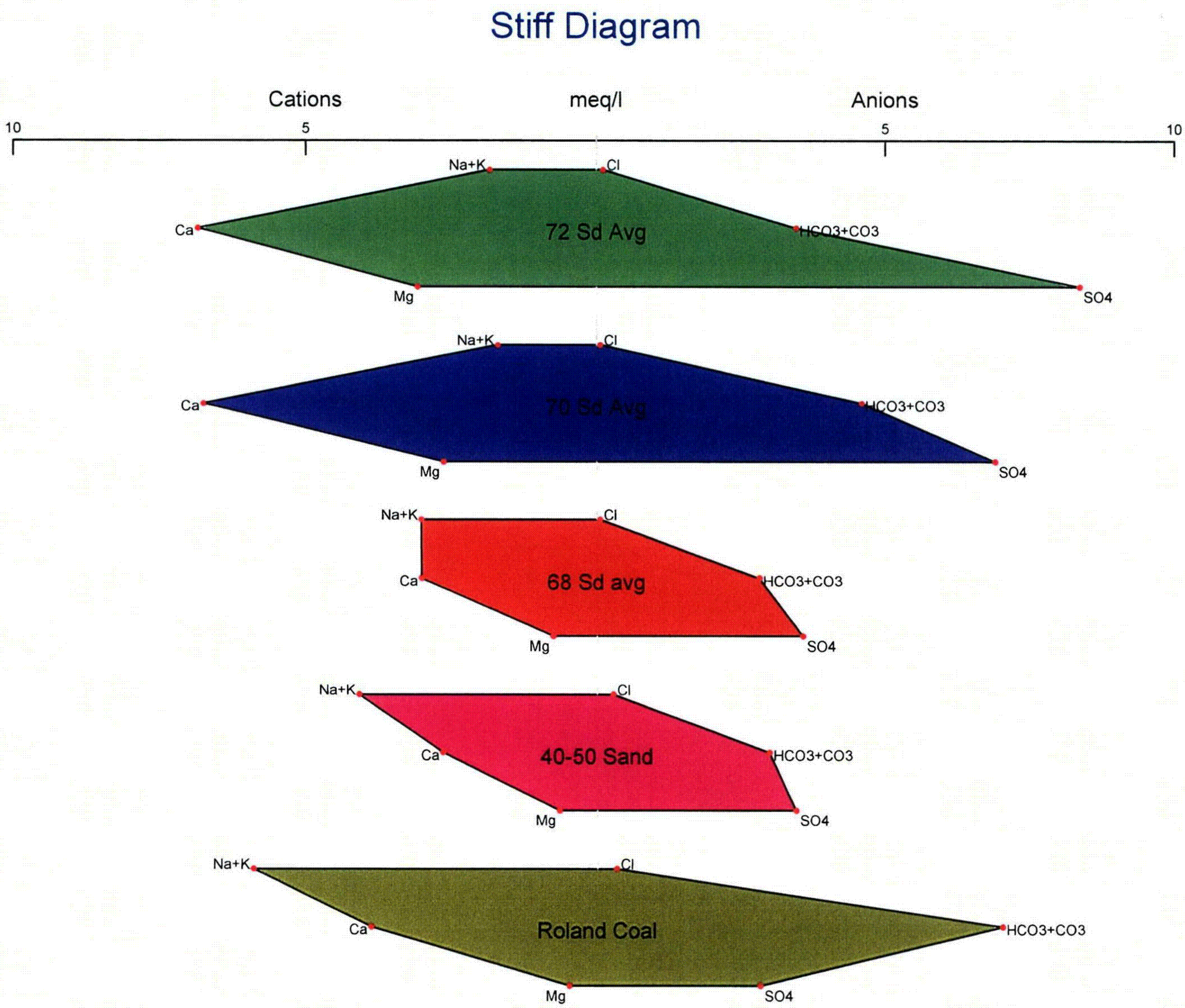

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Figure 2.7.3-5

Stiff Diagram-Water Quality in Aquifers Within the Permit Area, Moore Ranch

Project: 312-07	Date: March 2008	
Figure 2.7.3-5.ai	By: JLM	Checked: KC

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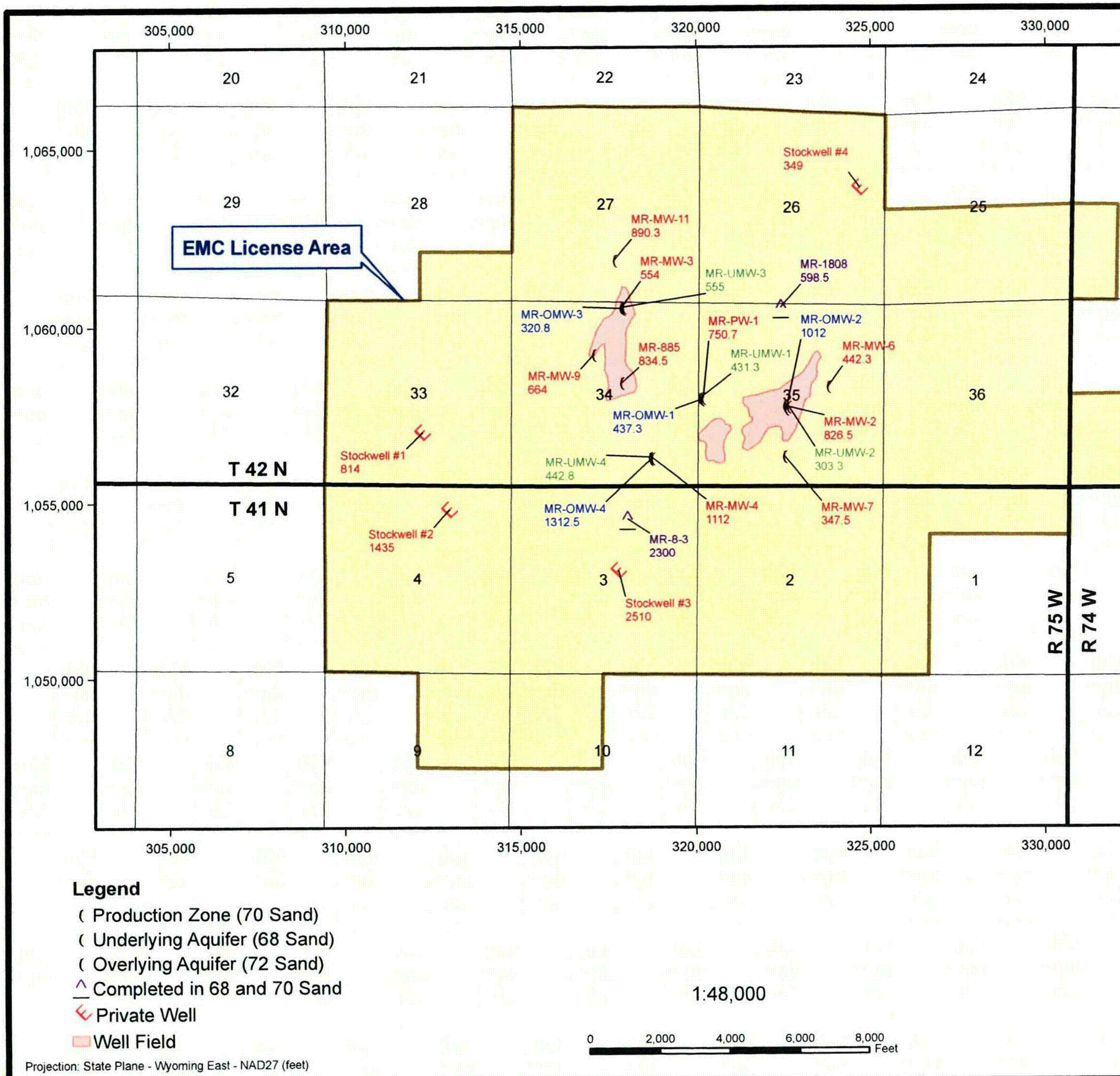

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Figure 2.7.3-6
2007 TDS Distribution
(mg/L)

Project: 312-7	Date: March 2008
Figure 2.7.3-6.mxd	By: JLM / Checked: KC

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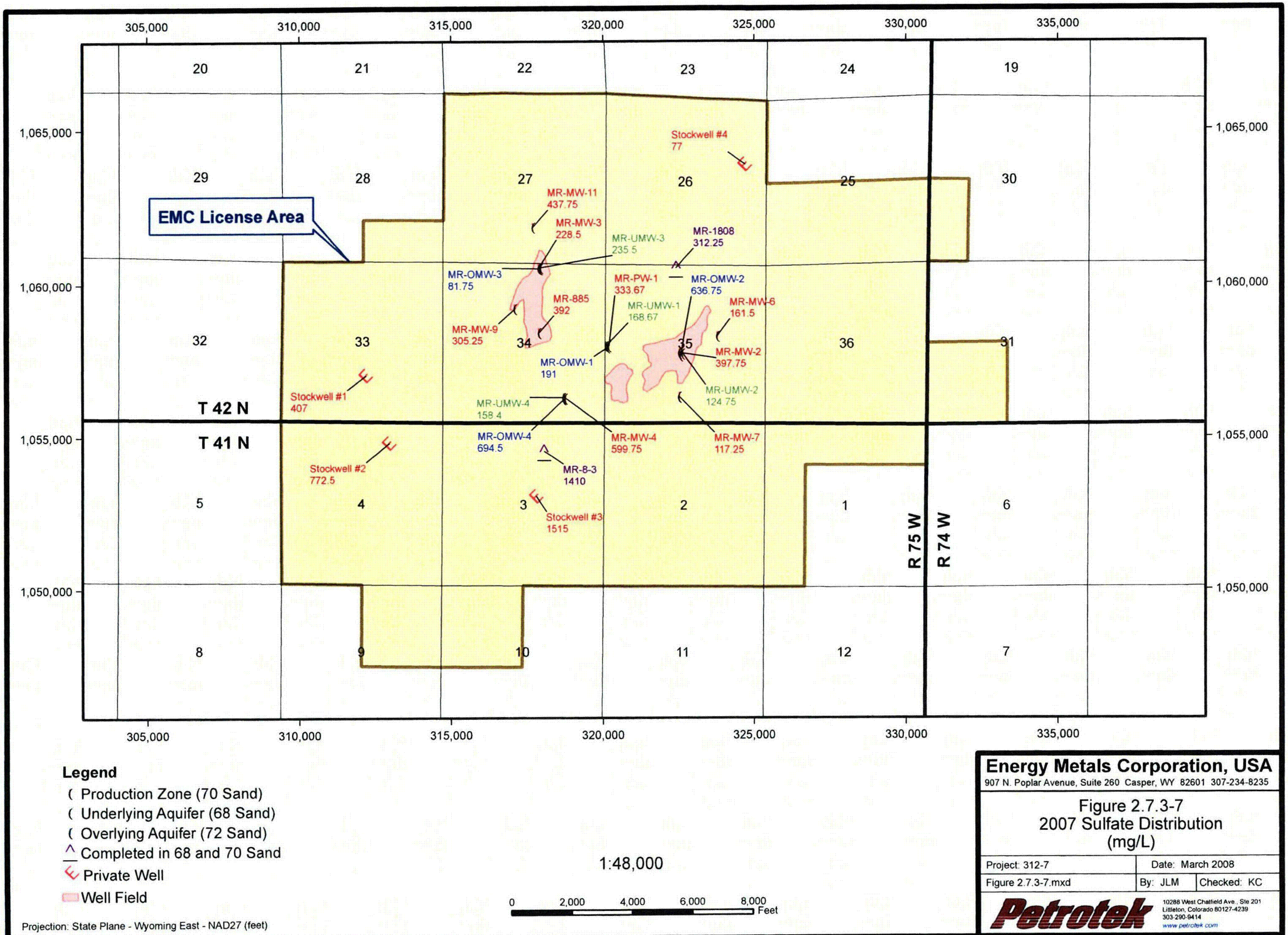
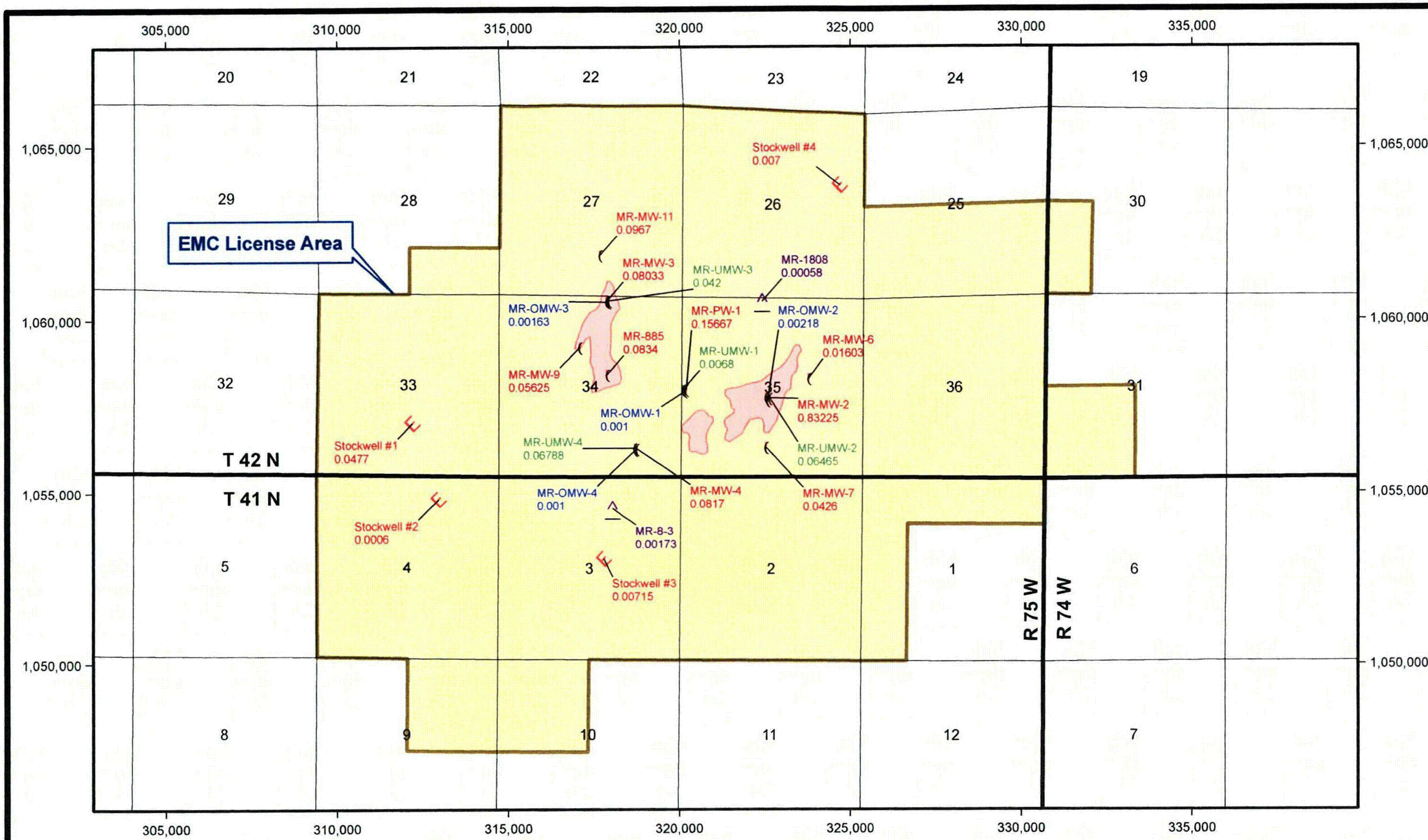


Figure 2.7.3-7
2007 Sulfate Distribution
(mg/L)



Legend

- (Production Zone (70 Sand)
- (Underlying Aquifer (68 Sand)
- (Overlying Aquifer (72 Sand)
- ^ Completed in 68 and 70 Sand
- Private Well
- Well Field

1:48,000

0 2,000 4,000 6,000 8,000 Feet

Projection: State Plane - Wyoming East - NAD27 (feet)

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Figure 2.7.3-8
2007 Uranium Distribution
(mg/L)

Project: 312-7	Date: March 2008
Figure 2.7.3-8.mxd	By: JLM / Checked: KC

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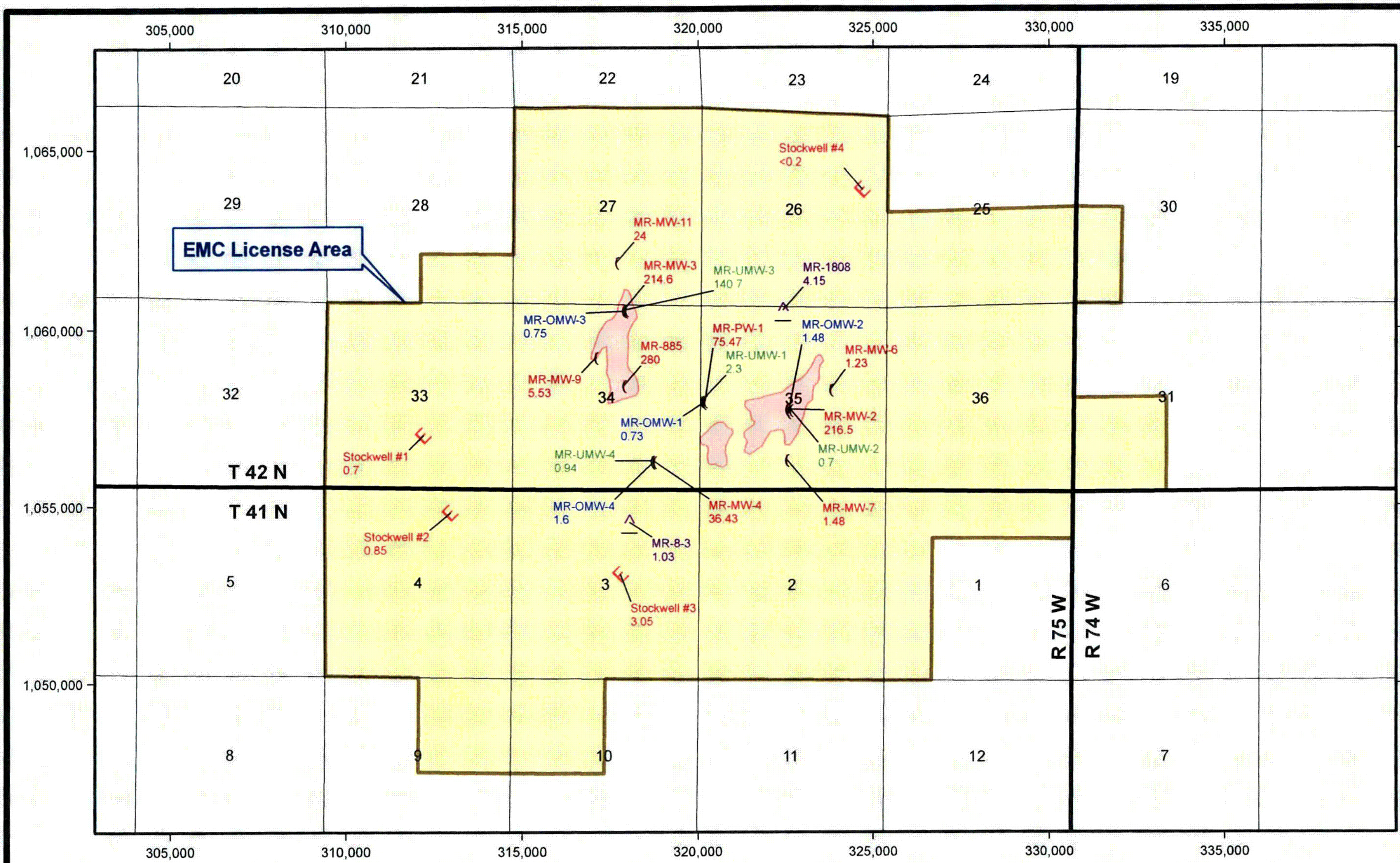

Legend

- Production Zone (70 Sand)
- Underlying Aquifer (68 Sand)
- Overlying Aquifer (72 Sand)
- Completed in 68 and 70 Sand
- Private Well
- Well Field

Projection: State Plane - Wyoming East - NAD27 (feet)

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Figure 2.7.3-9
2007 Radum-226 Distribution
(pCi/L)

Project: 312-7	Date: March 2008
Figure 2.7.3-9.mxd	By: JLM / Checked: KC

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