Lake Red Rock Groundwater Well Analysis

For Tainter Gate Repair Drawdown

January 2005

US Army Corps
of Engineers ®
Rock Island District

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FOR TAINTER GATE REPAIR DRAWDOWN

PROBLEM STATEMENT

Red Rock Lake and Dam was put into operation in 1968 for the purpose of flood control protection, low flow augmentation, recreation, and fish and wildlife management. The tainter gates on the Lake Red Rock dam are in need of repair. To accomplish this task, the pool elevation of the lake must be drawn down over an extended period of time. This drawdown will start approximately during the month of September 2007 and take around 20 days. The drawdown is from the conservation pool of 742.0 feet 1929 National Geodetic Vertical Datum (N.G.D.V) to 732.0 feet. N.G.D.V. Repairs will take an estimated one to two months with the pool being raised back to the conservation pool of 742.0 feet by January 2008, weather dependant. Throughout the history of the project, the minimum conservation pool has been raised. Table 1 shows a timeline for historic conservation pool level changes at Lake Red Rock. Raising or decreasing the conservation pool elevation can induce a slow raise or decline in the groundwater levels near the project.

Table 1. Timeline for Lake Red Rock Conservation Pool Changes

Year	Conservation Pool Elevation, Feet (1929 N.G.D.V.)
1969 (Reservoir in Operation)	725.0
1977	728.0
1988	734.0
1992	742.0

The city of Carlisle, after hearing of plans for the drawdown, contacted the Corps to ask if the planned drawdown would affect the city's municipal groundwater wells. In response the Rock Island District has investigated the groundwater wells in the surrounding area upstream of Lake Red Rock Dam. Municipalities in the area include Carlisle, near Des Moines River Mile 187, and Runnels, near Des Moines River Mile 180.

Paul VanDorpe from the Groundwater and Stratigraphic Studies Section of the Iowa Geological Survey was contacted to obtain a list of groundwater wells in the study area. Mr. VanDorpe provided a table that lists the wells as well as other pertinent data. This table can be found in Appendix A and on the internet through the Iowa Department of Natural Resources Geological Survey website http://gsbdata.igsb.uiowa.edu/geosam/.

SCOPE OF WORK

The scope of work for this investigation involved collecting Lake Red Rock pool data and available groundwater well readings. Once the historical data were entered, plots were made that show the pool elevations versus various well readings. Using these plots, a trend was developed and used to forecast how the pool draw down will affect the groundwater wells.

After trends were developed, Iowa Geological Survey data was used to determine the potential impact of the drawdown on the municipal groundwater wells as well as private wells in the study area. See Appendix B for map of the study area and locations of the Corps' groundwater monitoring wells. Conclusions were then developed and recommendations made as to the impact of the Lake Red Rock draw down on the municipal and private groundwater wells upstream of the Lake Red Rock Dam.

ENGINEERING ANALYSIS

Data for the Corps' groundwater monitoring wells and pool elevations was collected from a variety of sources. Historical groundwater data and the corresponding pool elevation from the start of operation of the project in 1968 to 1987 were taken from a report entitled "Analysis of Groundwater well data at Coralville, Saylorville, and Red Rock," which is dated June 22, 1988. More current data was collected through the Water Control section of the Hydraulics branch. This data is from 1994 to present. However, it should be noted that there is a gap in the data. There are no records from approximately 1979 to 1993. There are some well readings in the span from 1979 to 1987 but these readings are few and scattered.

Once the data was input into spreadsheets, plots were developed to show the relationship between the various Corps' groundwater wells and Lake Red Rock's pool elevation. These plots can be seen in Appendix C. These graphs show that some wells do respond to changes in the pool level at Red Rock Dam. However, attempts to define an overall relationship with a meaningful correlation coefficient failed. Static well water depth did rise after increasing the conservation pool elevation on several wells. The well water was higher than the lake level indicating precipitation, the source of most groundwater, which also affects the groundwater level elevation.

After these plots were developed, the table and descriptions provided by the Iowa Geological Survey were analyzed and compared with the data from the Corps' groundwater monitoring wells. This comparison was performed to estimate what will happen to the municipal groundwater wells when Lake Red Rock is drawn down for the repair of the tainter gates on the dam. Unfortunately, a lack of data, mainly elevation for the well location and the static water level for these other wells can make the analysis difficult.

The difficulty with private and public wells is the lack of a standard location for a global elevation measurement to be made. When wells are registered, a Township, Range, and section are required. Further divisions of the section are sometimes required and this location can help approximate elevation. However, several variables such as the total depth, static water level, and pumping water levels submitted on the well registration records are difficult to determine. Another source of vertical inaccuracy is the height of the pipe from the original ground level. Together, the elevation errors made by assumptions can equal the drawdown amount. Several unsuccessful attempts were made to contact local representatives of the City of Carlisle to obtain site specific data from their wells.

Groundwater flows are typically extremely slow (<500 ft/day). Lowering Lake Red Rock will not have in immediate effect on the regional groundwater levels. The wells in the region around

the lake draw from the water this is recharged by the uplands, the lake (after filling), and local precipitation. Groundwater will continue to flow generally from the uplands toward the Des Moines River valley during the drawdown of Lake Red Rock. Two sources of groundwater, precipitation and upland recharge, are still present and should be able to handle the demand for the winter months.

The occurrence of the drawdown over winter is also the time of low groundwater consumptive usage. A normal precipitation year should result in an adequate water supply for the fall and winter months and the spring runoff will refill the reservoir to the operation elevation of 742.0 ft N.G.V.D.

After comparing the Corps' groundwater well data with the table provided by the Iowa Geological Survey, several evaluations could be made. The first assessment can be made by looking at the plots found in Appendix C. These plots show that the groundwater wells generally mirror the fluctuations of the Lake Red Rock pool. Secondly, most of the municipal wells were constructed before Lake Red Rock's conservation pool was raised from 734.0 to 742.0 N.G.V.D. in 1992, making their pumpable water supply during the drawdown similar to the conditions when drilled. The table with the wells and their reported installation date can be found in Appendix A.

By comparing the dates in Table 1 with the dates of well construction in the table in Appendix A, those wells constructed after 1988 were deemed possible areas for concern. The reason for this is that before 1988, the pool elevation was 734.0 ft N.G.V.D., which is only two feet higher than the elevation of the drawdown. Those wells constructed pre-1988 should be considered safe because they were drilled when the pool elevation was 728.0 ft N.G.V.D. and would have had adequate water supply at that time. Therefore, a drawdown of ten feet to a pool elevation of 732.0 feet N.G.V.D. should not significantly affect these wells.

By analyzing the data in the table found in Appendix A, 11 groundwater wells were constructed after 1988. Based on assumed water recharge from precipitation and the general practices of well construction in the area, no significant adverse impacts due to pool drawdown at these wells are expected.

It should also be noted that the city of Knoxville has several groundwater wells but the date of construction is unknown. They are at an average depth of 32 ft. However, there is likely no affect to these groundwater wells as they were probably constructed pre-1988. Lastly, it should be noted that several wells in the table provided by the Iowa Geological Survey have an unknown depth and/or construction/permit date. For these wells, a conclusion and recommendation cannot be reached due to lack of data.

CONCLUSIONS

Some Corps monitoring wells showed a slight correlation with pool elevation and groundwater levels upstream of the Red Rock dam. Yet, due to the slow movement of groundwater and other sources of recharge (upland drainage and precipitation), most of the municipal wells upstream of the dam should not be significantly affected by the 10 foot drawdown scheduled for September

2007 and lasting until January 2008. Of the public municipal wells where the installation date is known, none are expected to be reduced to an inadequate pumping level. These findings are based on a review of available hydrologic information as described with coordination and concurrence of the Geotechnical Branch of the Rock Island District Corps of Engineers.

REFERENCES

Louise and Paul Kallemeyn (p.l.kallemeyn@mchsi.com), Ground water well data 1994 to present for Iowa and Des Moines Rivers.

Shive-Hattery Engineers and Architects, Inc., Moline, Illinois, "Analysis of Groundwater well data at Coralville, Saylorville, and Red Rock," dated June 22, 1988

Paul VanDorpe, Groundwater and Stratigraphic Studies Section of the Iowa Geological Survey, Iowa City, Iowa

APPENDIX A

Iowa Geological Survey Groundwater Well Table

Well Search Results

IGS well database

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
1	39830	T. 78 N., R. 23 W., Sec. 16, SE, SE, NE	32	8/8/1996	Morgan, Ron	Bedrock depth unkn
6	8406	T. 78 N., R. 23 W., Sec. 28	45	1/1/1956	General Mills	Bedrock depth 30 ft.; scanned log available
7	8440	T. 78 N., R. 23 W., Sec. 28	35	1/1/1956	General Mills	Bedrock depth 30 ft.; scanned log available
8	8431	T. 78 N., R. 23 W., Sec. 28	35	1/1/1956	General Mills	Bedrock depth 25 ft.; scanned log available
10	26610	T. 78 N., R. 22 W., Sec. 30, NW, SW	75	8/16/1979	Polk County Rwd	Bedrock depth 25 ft.
13	36826	T. 78 N., R. 23 W., Sec. 28, SW	62	7/26/1995	Pre-mix	Bedrock depth 56 ft.
17	48293	T. 78 N., R. 23 W., Sec. 29, SE, SE	54	1/8/1999	Brasel, Christina	Bedrock depth 22 ft.
20	11196	T. 78 N., R. 23 W., Sec. 28, SE, SE, NW, SW	2428	1/7/1960	General Mills	Bedrock depth 25 ft.; scanned log available
24	8430	T. 78 N., R. 23 W., Sec. 28	40	1/1/1956	General Mills	Bedrock depth 35 ft.; scanned log available
29	26611	T. 78 N., R. 22 W., Sec. 30, SW, SW	50	8/17/1979	Polk County Rwd	Bedrock depth unkn
39	26614	T. 78 N., R. 22 W., Sec. 32, NW, NW	50	9/11/1979	Polk County Rwd	Bedrock depth 30 ft.
41	26613	T. 78 N., R. 22 W., Sec. 32, NW, NW	50	9/6/1979	Polk County Rwd	Bedrock depth 25 ft.
45	50434	T. 78 N., R. 23 W., Sec. 33	44	7/26/1999	Belzer, Robert	Bedrock depth unkn
49	50433	T. 78 N., R. 23 W., Sec. 33	46	7/23/1999	Goodhue, Casey & Stephany	Bedrock depth unkn
53	26612	T. 78 N., R. 22 W., Sec. 31, NE, SW	50	8/23/1979	Polk County Rwd	Bedrock depth unkn
54	17606	T. 78 N., R. 22 W., Sec. 32, NE, SW	189	1/1/1965	Cage, Clifford	Bedrock depth unkn; scanned log available
56	24973	T. 78 N., R. 22 W., Sec. 32, SE, NE, NW, NW	372	7/1/1977	Heathershaw, Miles	Bedrock depth 15 ft.
59	37787	T. 78 N., R. 23 W., Sec. 34, SE, SE, NW, SE	30	10/3/1979	Carlisle, City Of	Bedrock depth unkn
63	37116	T. 78 N., R. 23 W., Sec. 34, SE, SE, SW, NE	50	1/1/1971	Carlisle, City Of	Bedrock depth unkn
64	37115	T. 78 N., R. 23 W., Sec. 34, SE, SE, SE, SE, NW	43	1/1/1957	Carlisle, City Of	Bedrock depth unkn
69	37114	T. 77 N., R. 23 W., Sec. 3, NE, NE, NE, NE	43	10/1/1951	Carlisle, City Of	Bedrock depth unkn
71	5321	T. 77 N., R. 23 W., Sec. 3, NE, NE, NE	36	unkn	Carlisle, City Of	Bedrock depth 35 ft.; scanned log available
74	37117	T. 77 N., R. 23 W., Sec. 3	50	1/1/1949	Carlisle, City Of	Bedrock depth unkn
75	12272	T. 78 N., R. 22 W., Sec. 35	55	7/21/1960	Runnells, City Of	Bedrock depth unkn; scanned log available
79	41718	T. 78 N., R. 22 W., Sec. 35	48	8/28/1952	Runnells, City Of	Bedrock depth unkn
81	37788	T. 77 N., R. 23 W., Sec. 3	30	1/1/1920	Carlisle, City Of	Bedrock depth unkn
82	37791	T. 77 N., R. 23 W., Sec. 3	60	1/1/1941	Carlisle, City Of	Bedrock depth 35 ft.
83	37118	T. 77 N., R. 23 W., Sec. 3	30	1/1/1938	Carlisle, City Of	Bedrock depth unkn
85	37119	T. 77 N., R. 23 W., Sec. 3	30	1/1/1920	Carlisle, City Of	Bedrock depth unkn
89	37790	T. 77 N., R. 23 W., Sec. 3	30	1/1/1935	Carlisle, City Of	Bedrock depth unkn
90	37789	T. 77 N., R. 23 W., Sec. 3	30	1/1/1935	Carlisle, City Of	Bedrock depth unkn
95	3622	T. 77 N., R. 23 W., Sec. 2, SW, NW, NW	50	unkn	Carlisle, City Of	Bedrock depth unkn; scanned log available
96	13446	T. 77 N., R. 22 W., Sec. 5	45	1/1/1962	Carlisle Sand & Gravel	Bedrock depth unkn; scanned log available
108	35078	T. 77 N., R. 21 W., Sec. 17, SW, SW, NE, SW	unkn	1/1/1967	Swan, City Of	Bedrock depth unkn
112	21844	T. 77 N., R. 20 W., Sec. 35, NE, SE	188	4/1/1969	Eraco Corp Lots	Bedrock depth 30 ft.
113	21891	T. 77 N., R. 20 W., Sec. 35, NE, SE	232	4/8/1969	Eraco Corp Lots	Bedrock depth 35 ft.
114	18775	T. 77 N., R. 20 W., Sec. 35, NE, SE, SE	191	4/7/1966	Eraco Coop	Bedrock depth unkn; scanned log available
115	18757	T. 77 N., R. 20 W., Sec. 35, NE, SE, SE	185	4/14/1966	Eraco Coop	Bedrock depth unkn; scanned log available

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
116	22284	T. 77 N., R. 20 W., Sec. 35	157	2/12/1970	Eraco Corp Lots	Bedrock depth 5 ft.
117	21839	T. 77 N., R. 20 W., Sec. 35	175	5/19/1969	Eraco Corp Lots	Bedrock depth 20 ft.
118	22937	T. 77 N., R. 20 W., Sec. 35	177	5/15/1971	Eraco Core	Bedrock depth 30 ft.
119	22292	T. 77 N., R. 20 W., Sec. 35	146	2/17/1970	Eraco Corp Lots	Bedrock depth 5 ft.
120	20514	T. 77 N., R. 20 W., Sec. 35	162	1/8/1968	Eraco Corp Lots	Bedrock depth 25 ft.
121	20424	T. 77 N., R. 20 W., Sec. 35	205	1/6/1968	Eraco Corp Lots	Bedrock depth 20 ft.
122	19855	T. 77 N., R. 20 W., Sec. 35	188	6/1/1967	Eraco Corporation	Bedrock depth unkn; scanned log available
123	18766	T. 77 N., R. 20 W., Sec. 36	225	2/20/1966	Coop, Eraco	Bedrock depth unkn; scanned log available
124	21772	T. 77 N., R. 20 W., Sec. 35	187	4/28/1969	Eraco Corp Lots	Bedrock depth unkn
125	21931	T. 77 N., R. 20 W., Sec. 35	183	9/26/1969	Eraco Corp Lots	Bedrock depth 30 ft.
126	21865	T. 77 N., R. 20 W., Sec. 35	223	5/14/1969	Eraco Corp Lot	Bedrock depth 30 ft.
127	20480	T. 77 N., R. 20 W., Sec. 35	185	1/22/1968	Eraco Corp	Bedrock depth 30 ft.
128	1423	T. 77 N., R. 20 W., Sec. 36, SE, NE, SW, NW	220	unkn	Core Well	Bedrock depth unkn; scanned log available
129	22159	T. 77 N., R. 19 W., Sec. 31, SE, SW	245	6/24/1969	Iowa Conservation Commission	Bedrock depth unkn
130	25215	T. 76 N., R. 19 W., Sec. 4, NW, NW	235	7/2/1977	Huelse, Ron	Bedrock depth unkn
131	3115	T. 76 N., R. 19 W., Sec. 4, NE, NW, SE	127	unkn	Kuyper, Ralph	Bedrock depth 35 ft.; scanned log available
132	4237	T. 76 N., R. 19 W., Sec. 5	37	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
133	9770	T. 76 N., R. 19 W., Sec. 3	87	unkn	Wink, John	Bedrock depth unkn; scanned log available
134	4562	T. 76 N., R. 20 W., Sec. 1	131	unkn	Streeter, W. H.	Bedrock depth unkn; scanned log available
135	28682	T. 76 N., R. 20 W., Sec. 1, SE, NW	157	8/22/1983	Nichols, Sam	Bedrock depth 25 ft.
136	22501	T. 76 N., R. 19 W., Sec. 3, SE, NE, SW, SW	140	8/11/1970	U.s. Army Corps Of Engineers	Bedrock depth 70 ft.
137	4239	T. 76 N., R. 19 W., Sec. 5, SE	30	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
138	4236	T. 76 N., R. 19 W., Sec. 5, SE	35	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
139	4240	T. 76 N., R. 19 W., Sec. 5, SE	32	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
140	4234	T. 76 N., R. 19 W., Sec. 5, SE	31	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
141	4235	T. 76 N., R. 19 W., Sec. 5, SE	34	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
142	4238	T. 76 N., R. 19 W., Sec. 5, SE	37	unkn	Knoxville, City Of	Bedrock depth unkn; scanned log available
143	22358	T. 76 N., R. 20 W., Sec. 1, SE, SW, SW	233	5/19/1970	Iowa Conservation Commission	Bedrock depth 35 ft.; scanned log available
144	22558	T. 76 N., R. 19 W., Sec. 11, NW, NE, SE, SE	155	8/17/1970	U.s. Army Corps Of Engineers	Bedrock depth 20 ft.
145	1607	T. 76 N., R. 20 W., Sec. 12, NE, SE, NE	125	unkn	Jennings	Bedrock depth 30 ft.; scanned log available
146	22589	T. 76 N., R. 19 W., Sec. 12, SW, NW, SE	166	9/16/1970	U.s. Army Corps Of Engineers	Bedrock depth 65 ft.; scanned log available
147	22599	T. 76 N., R. 19 W., Sec. 10, SW, SW, SE, SW	135	10/29/1970	U.s. Army Corps Of Engineers	Bedrock depth 20 ft.
148	7909	T. 76 N., R. 19 W., Sec. 22	197	unkn	Crosby, W.b.	Bedrock depth unkn; scanned log available
149	20037	T. 76 N., R. 19 W., Sec. 22	175	8/8/1967	Avery, Robert W.	Bedrock depth unkn; scanned log available
150	9545	T. 76 N., R. 19 W., Sec. 19	100	unkn	Vanderlinden, Roy E.	Bedrock depth unkn; scanned log available
151	1605	T. 76 N., R. 20 W., Sec. 34, NE, SW, SW, SW	205	unkn	Kerr, Bert	Bedrock depth 15 ft.; scanned log available
152	18694	T. 75 N., R. 20 W., Sec. 4, SE, NE, SE	206	6/3/1966	Tonda, Joe	Bedrock depth 40 ft.; scanned log available
153	4011	T. 75 N., R. 20 W., Sec. 3, SW, NW, SW	220	unkn	Henning, W.c.	Bedrock depth 40 ft.; scanned log available

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information

Public wells (municipal)

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
61	37787	T. 78 N., R. 23 W., Sec. 34, SE, SE, NW, SE	30	10/3/1979	Carlisle, City Of	Bedrock depth unkn; Well status: Primary; Local id: #5
62	37116	T. 78 N., R. 23 W., Sec. 34, SE, SE, SW, NE	50	1/1/1971	Carlisle, City Of	Bedrock depth unkn; Well status: Primary; Local id: #4
65	37115	T. 78 N., R. 23 W., Sec. 34, SE, SE, SE, SE, NW	43	1/1/1957	Carlisle, City Of	Bedrock depth unkn; Well status: Primary; Local id: #3
70	37114	T. 77 N., R. 23 W., Sec. 3, NE, NE, NE, NE	43	10/1/1951	Carlisle, City Of	Bedrock depth unkn; Well status: Primary; Local id: #2
72	5321	T. 77 N., R. 23 W., Sec. 3, NE, NE, NE	36	9/1/1951	Carlisle, City Of	Bedrock depth: 34; Well status: Abandoned; Local id: #1
73	41718	T. 78 N., R. 22 W., Sec. 35	48	8/28/1952	Runnells, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: #1
76	12272	T. 78 N., R. 22 W., Sec. 35	48	1/1/1960	Runnells, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: #2
78	37117	T. 77 N., R. 23 W., Sec. 3	50	1/1/1949	Carlisle, City Of	Bedrock depth unkn; Well status: Plugged; Local id: # OLD
80	37118	T. 77 N., R. 23 W., Sec. 3	30	1/1/1938	Carlisle, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: # GRAVEL-P
84	37788	T. 77 N., R. 23 W., Sec. 3	30	1/1/1920	Carlisle, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: # ONE OF T
86	37119	T. 77 N., R. 23 W., Sec. 3	30	1/1/1920	Carlisle, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: # ONE OF T
87	37791	T. 77 N., R. 23 W., Sec. 3	60	1/1/1941	Carlisle, City Of	Bedrock depth: 35; Well status: Abandoned; Local id: # ??
88	37789	T. 77 N., R. 23 W., Sec. 3	30	1/1/1935	Carlisle, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: # ONE OF T
91	37790	T. 77 N., R. 23 W., Sec. 3	30	1/1/1935	Carlisle, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: # SANDPOIN
107	35078	T. 77 N., R. 21 W., Sec. 17, SW, SW, NE, SW	34	1/1/1967	Swan, City Of	Bedrock depth unkn; Well status: Abandoned; Local id: #1

Public wells (non-municipal)

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
19	11196	T. 78 N., R. 23 W., Sec. 28, SE, SE, NW, NW	2428	1/7/1960	General Mills Operations, Inc	Bedrock depth: 25; Well status: Primary
23	8430	T. 78 N., R. 23 W., Sec. 28, SE, SE, NW, SE	40	1/1/1956	General Mills Operations, Inc	Bedrock depth: 35; Well status: Standby

Private well tracking system wells

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
33	2091502	T. 78 N., R. 23 W., Sec. 34, NW NW NW SE NE	22	1/1/1972	Theobald, Ed	Status: Active Use: Household Program source: Well testing
35	2095578	T. 78 N., R. 23 W., Sec. 34, NW NW NE SW SW	28	1/1/1970	Batterson, Janet	Status: Active Use: Program source: Well testing
37	2099664	T. 78 N., R. 23 W., Sec. 34	45	6/1/1970	Burdine, Ron	Status: Active Use: Program source: Well testing
40	2089894	T. 78 N., R. 23 W., Sec. 34, NW NW SW SE SW	28	1/1/1974	Smeby, Royden	Status: Active Use: Household Program source: Well testing
110	2096802	T. 77 N., R. 22 W., Sec. 26, SE SW NW SW SE	40	1/1/1960	Fugate, Steve & Wende	Status: Active Use: Program source: Well testing

Wells registered for testing

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
11	55086	T. 78 N., R. 23 W., Sec. 29, SE, NE, SW	54	1998	Brasel, Christina	Drilling method: Augered; Known well depth
14	76895	T. 78 N., R. 23 W., Sec. 29, SE, SE, NE	50	1980	Logan, Bruce	Drilling method: Driven; Known well depth
15	76893	T. 78 N., R. 23 W., Sec. 29, SE, SE, NE	40	1975	Beck, Curtis	Drilling method: Bored; Known well depth

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
21	76897	T. 78 N., R. 23 W., Sec. 29, SE, SE, SW	150	1995	Versteeg, Lisa	Drilling method: Drilled; Known well depth
22	76896	T. 78 N., R. 23 W., Sec. 29, SE, SE, SW	150	1995	Versteeg, Lisa	Drilling method: Drilled; Known well depth
30	21471	T. 78 N., R. 23 W., Sec. 33, NE, NE, NE	unkn	unkn	Penman, Kathy	Drilling method: Sandpoint;
31	60937	T. 78 N., R. 23 W., Sec. 34, NW, NW, NE	20	1960	Dainty, Scott	Drilling method: Driven; Known well depth
32	60938	T. 78 N., R. 23 W., Sec. 34, NW, NW, NE	20	1960	Dainty, Scott	Drilling method: Driven; Known well depth
42	52573	T. 78 N., R. 23 W., Sec. 34, NW, SE, NW	30	1970	Davidson, Charlotte	Drilling method: Driven; Known well depth
44	76916	T. 78 N., R. 23 W., Sec. 34, NW, SW, SW	25	1970	Bickford, Betty	Drilling method: Driven; Known well depth
46	55088	T. 78 N., R. 23 W., Sec. 34, NW, SE, SW	30	1995	King, Jeff	Drilling method: Augered; Known well depth
47	76917	T. 78 N., R. 23 W., Sec. 34, NW, SW, SW	25	1975	Albritton, Kim	Drilling method: Driven; Known well depth
50	26818	T. 78 N., R. 23 W., Sec. 32, SE, NE, NE	unkn	unkn	Seyferer, Kay	Drilling method: Bored; Well depth is uncertain
51	26999	T. 78 N., R. 23 W., Sec. 32, SE, NE, NE	unkn	unkn	Seuferer, Kay	Drilling method: Bored; Well depth is uncertain
66	7567	T. 77 N., R. 23 W., Sec. 5, NE, NE	44	1992	Rogers, Steven	Drilling method: Bored; Known well depth
67	25609	T. 77 N., R. 23 W., Sec. 5, NE, NE	40	1993	Rogers, Steven	Drilling method: Bored;
77	64106	T. 77 N., R. 23 W., Sec. 4, NW, NE, SE	35	1975	Fisher, Margie	Drilling method: Bored; Known well depth
92	13369	T. 77 N., R. 23 W., Sec. 1, NW, NW	112	1987	Mid American Energy, c/o Del Wynn	Drilling method: Drilled; Known well depth
93	28265	T. 77 N., R. 23 W., Sec. 2, NW, SW	150	1972	Smith, Billy	Drilling method: Bored; Known well depth
94	27462	T. 77 N., R. 23 W., Sec. 1, NE, SE	50	unkn	Dearinger, Dave	Drilling method: Dug;
97	27447	T. 77 N., R. 23 W., Sec. 2, SE, SW	55	1970	Halvorsen, Jeff	Drilling method: Bored; Known well depth
101	23909	T. 77 N., R. 22 W., Sec. 12, SW, SW	28	1965	Johnston, Jim	Drilling method: Bored; Known well depth
102	12317	T. 77 N., R. 22 W., Sec. 13, NE, NE, NE	36	1950	Wiley, Tim & Sharon	Drilling method: Bored;
103	12315	T. 77 N., R. 22 W., Sec. 13, NE, NE, NE	30	1950	Wiley, Tim & Sharon	Drilling method: Bored;
104	50747	T. 77 N., R. 22 W., Sec. 13, NW, NE, SW	30	1957	Walter, Rc	Drilling method: Bored; Known well depth
105	37044	T. 77 N., R. 22 W., Sec. 13, NW, NE, SW	30	1957	Walter, Rc	Drilling method: ;
106	58086	T. 77 N., R. 22 W., Sec. 13, NW, NE, SW	30	1957	Walter, Rc	Drilling method: Bored; Known well depth
109	25826	T. 77 N., R. 22 W., Sec. 23, NE, SE	45	1985	Pendry, Dale	Drilling method: Bored;
111	470	T. 77 N., R. 22 W., Sec. 26, SW, SE	4	1976	Coal, Lyle	Drilling method: Bored; Estimated well depth

Permitted private wells

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
2	18994	T. 78 N., R. 23 W., Sec. 21, SE, SE, SE	unkn	unkn	Mid America Energy	Primary use: Public water supply
3	14585	T. 78 N., R. 23 W., Sec. 29, NE, NE	50	unkn	Unkn	Primary use: Domestic/household
4	23582	T. 78 N., R. 23 W., Sec. 27, , , , NW, SW	unkn	12/21/1998	Tilton	Primary use: household
12	16785	T. 78 N., R. 23 W., Sec. 28, SE, NW, SE	unkn	unkn	Unkn	Primary use: Domestic/household
16	14601	T. 78 N., R. 23 W., Sec. 29, SE, SE	150	10/2/1991	Unkn	Primary use: Industrial/Commericial
18	14554	T. 78 N., R. 23 W., Sec. 28, SW, SW	40	unkn	Unkn	Primary use: Domestic/household
25	14707	T. 78 N., R. 23 W., Sec. 27, SW, SW	unkn	unkn	Unkn	Primary use: Industrial/Commericial
26	14594	T. 78 N., R. 23 W., Sec. 27, SW, SE	35	unkn	Unkn	Primary use: Domestic/household
27	14538	T. 78 N., R. 23 W., Sec. 27, SE, SE	31	unkn	Unkn	Primary use: Domestic/household
28	14641	T. 78 N., R. 23 W., Sec. 28, SE, SE, SE	60	unkn	Unkn	Primary use: Domestic/household
34	14689	T. 78 N., R. 23 W., Sec. 34, NW, NW	30	unkn	Unkn	Primary use: Domestic/household

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
36	14572	T. 78 N., R. 23 W., Sec. 34, NW, NW	30	unkn	Unkn	Primary use: Domestic/household
38	16787	T. 78 N., R. 23 W., Sec. 34, NW	unkn	unkn	Unkn	Primary use: Domestic/household
43	14564	T. 78 N., R. 23 W., Sec. 33, NE, SW	unkn	unkn	Unkn	Primary use: Domestic/household
48	16788	T. 78 N., R. 23 W., Sec. 33	unkn	unkn	Unkn	Primary use: Domestic/household

Public water supply wells and intakes

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
57	3105	T78N, R23W, Sec. 34	n.a.	n.a.	Carlisle	n.a.
58	3105	T78N, R23W, Sec. 34	n.a.	n.a.	Carlisle	n.a.
60	3105	T78N, R23W, Sec. 34	n.a.	n.a.	Carlisle	n.a.
68	3105	T77N, R23W, Sec. 3	n.a.	n.a.	Carlisle	n.a.

Water use permit facilities

Map Id	Well No.	Location	Well depth	Construction/ Permit date	Owner/Permittee	Other information
5	963	T. 78 N., R. 23 W., Sec. 28	n.a.	n.a.	General Mills, Inc.	Source: Well, 2 wells authorized, Use: Service (car wash, laundry, etc.)
9	4881	T. 78 N., R. 23 W., Sec. 27	n.a.	n.a.	Martin Marietta Aggregates, Inc.	Source: Reservoir, Use: Material prod., dewatering only
52	3105	T. 78 N., R. 23 W., Sec. 34	n.a.	n.a.	Carlisle, City Of	Source: Well, 4 wells authorized, Use: Municipal
55	7171	T. 78 N., R. 22 W., Sec. 32	n.a.	n.a.	Roseland, Kurt R.	Source: Well, 1 wells authorized, Use: Recreational
98	7187	T. 77 N., R. 22 W., Sec. 9	n.a.	n.a.	Iowa Department Of Natural Resource	Source: Stream, Use: Recreational
99	7188	T. 77 N., R. 22 W., Sec. 11	n.a.	n.a.	Iowa Department Of Natural Resource	Source: Stream, Use: Recreational
100	5710	T. 77 N., R. 21 W., Sec. 7	n.a.	n.a.	Idnr Wildlife Bureau--red Rock Wildlife	Source: Stream, Use: Recreational

APPENDIX B

Map of Wells and Study Area

Ground Water Wells

Mississippi Valley Rock Island District
Des Moines River Basin
Location Map

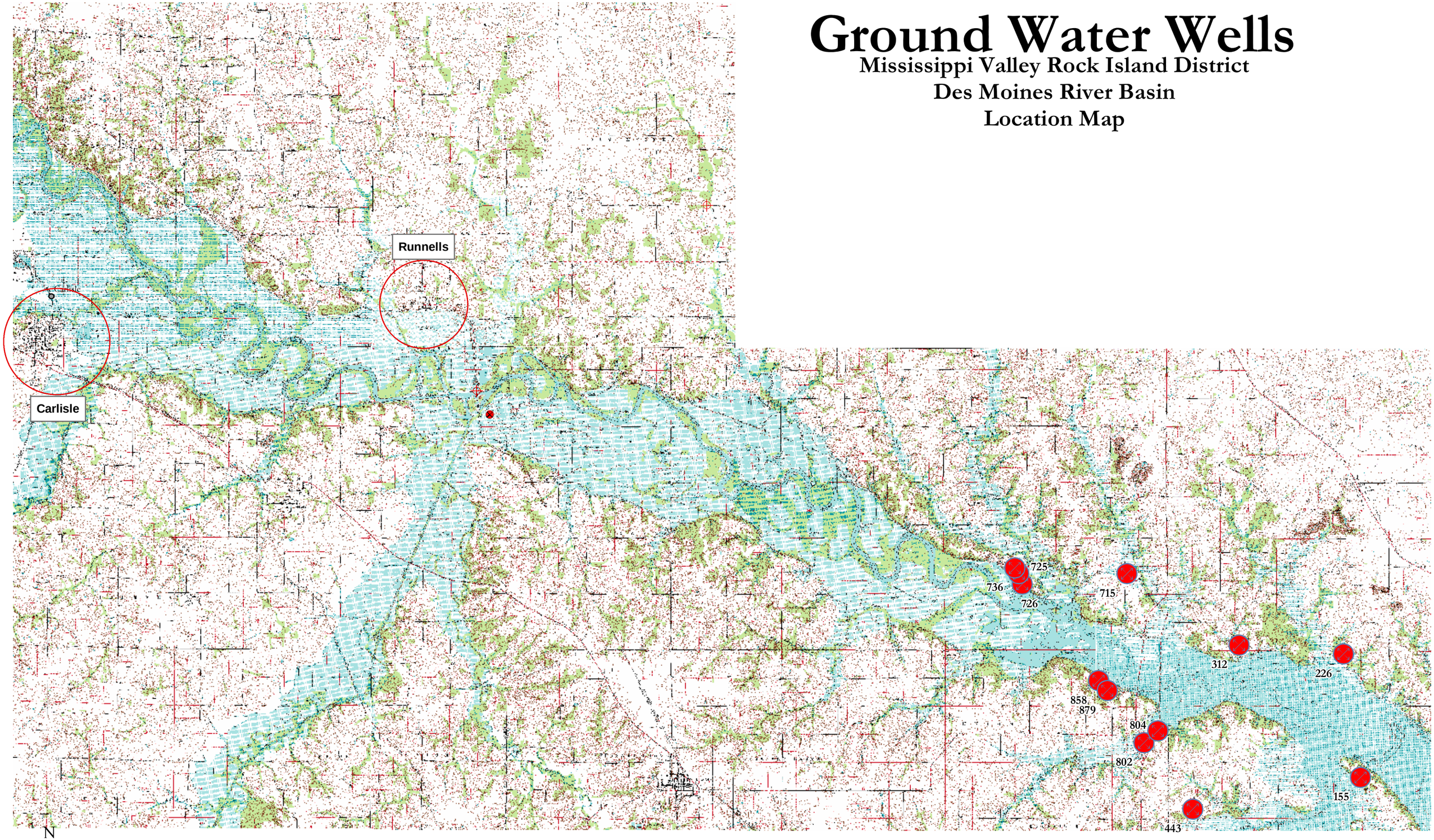


PLATE 1

Ground Water Wells

Mississippi Valley Rock Island District

Des Moines River Basin

725
726
715
312
226
858
879
804
802
443
155

N

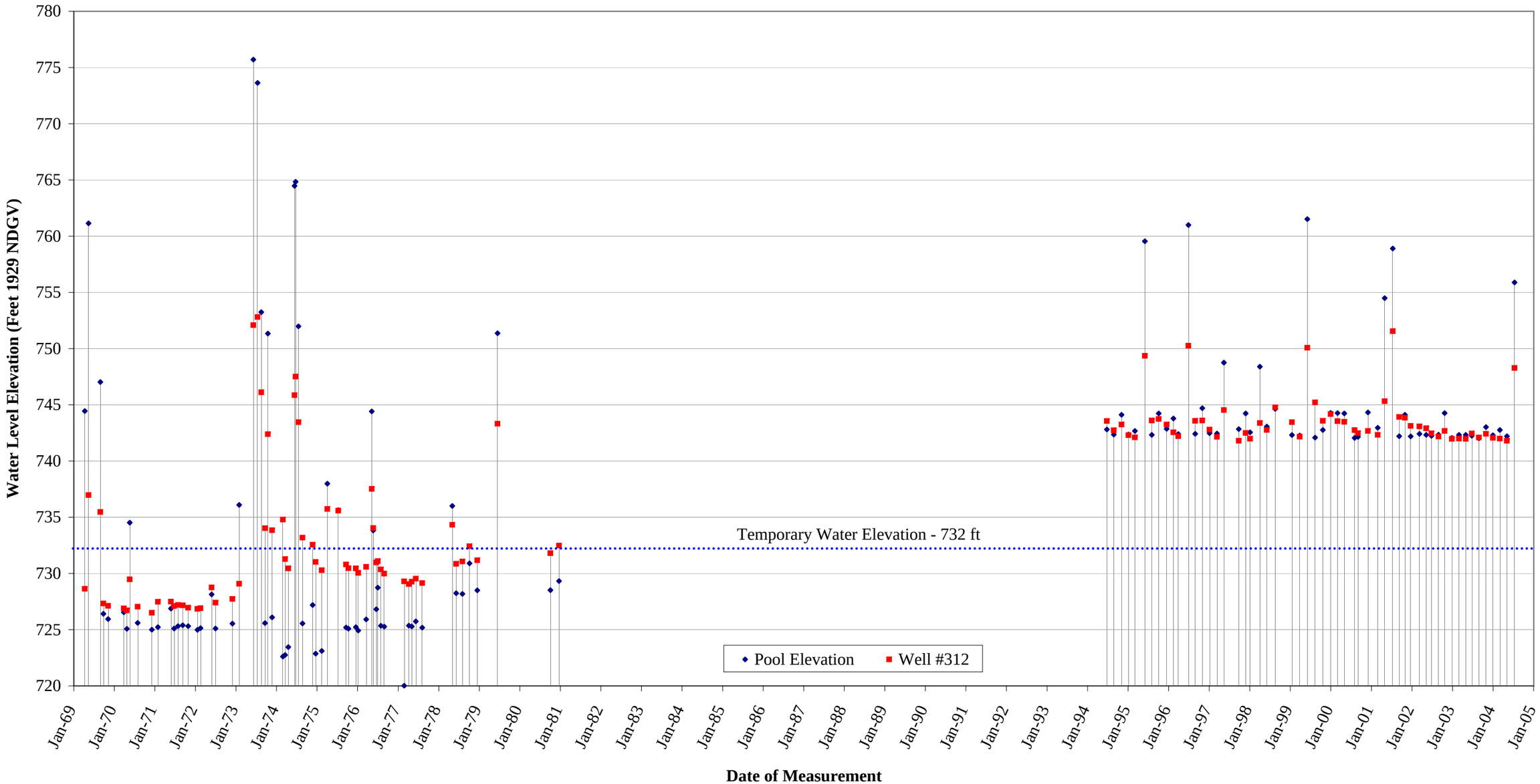
1 Miles

PLATE 2

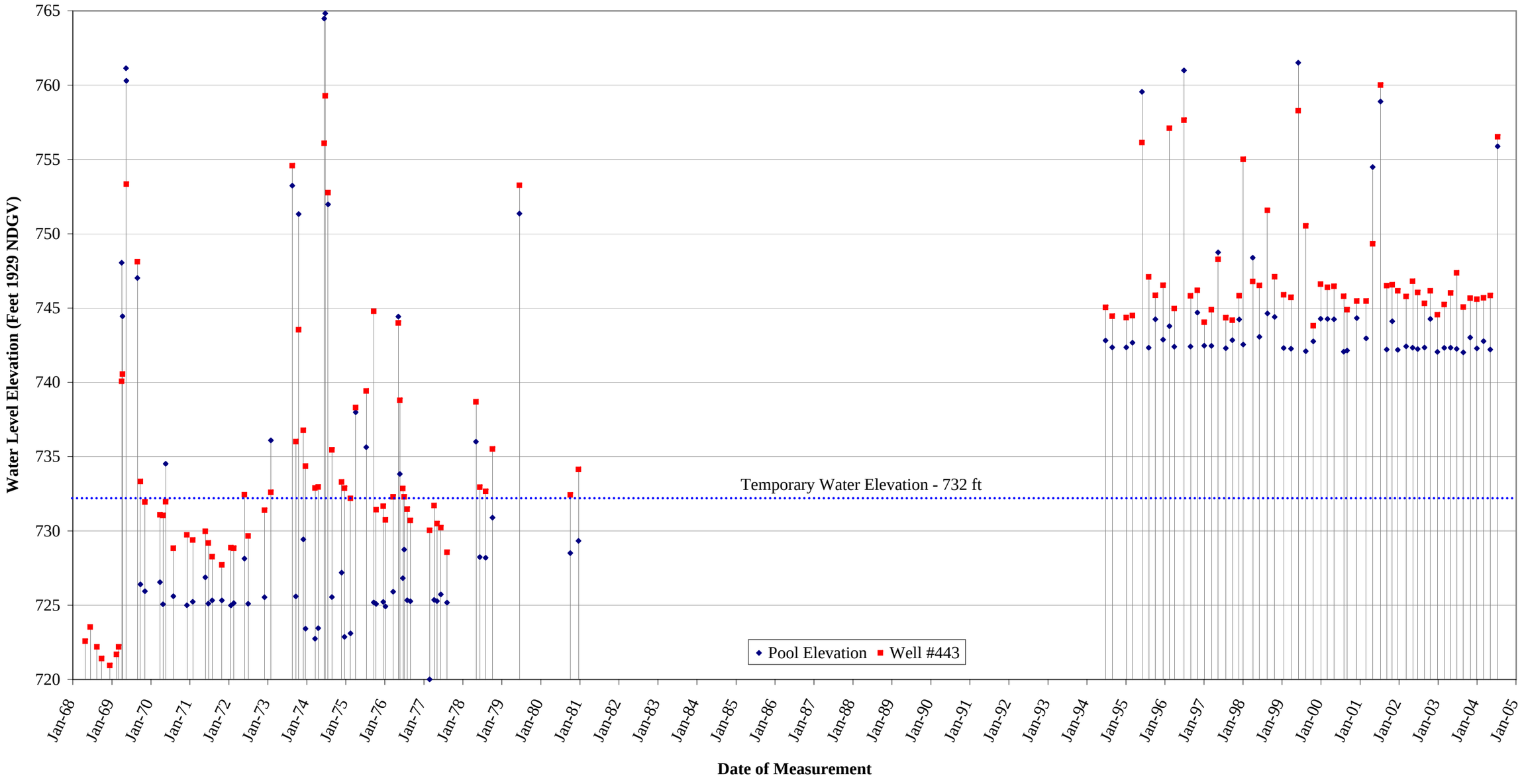
APPENDIX C

Plots of Corp's Groundwater Wells versus Red Rock Pool Elevations

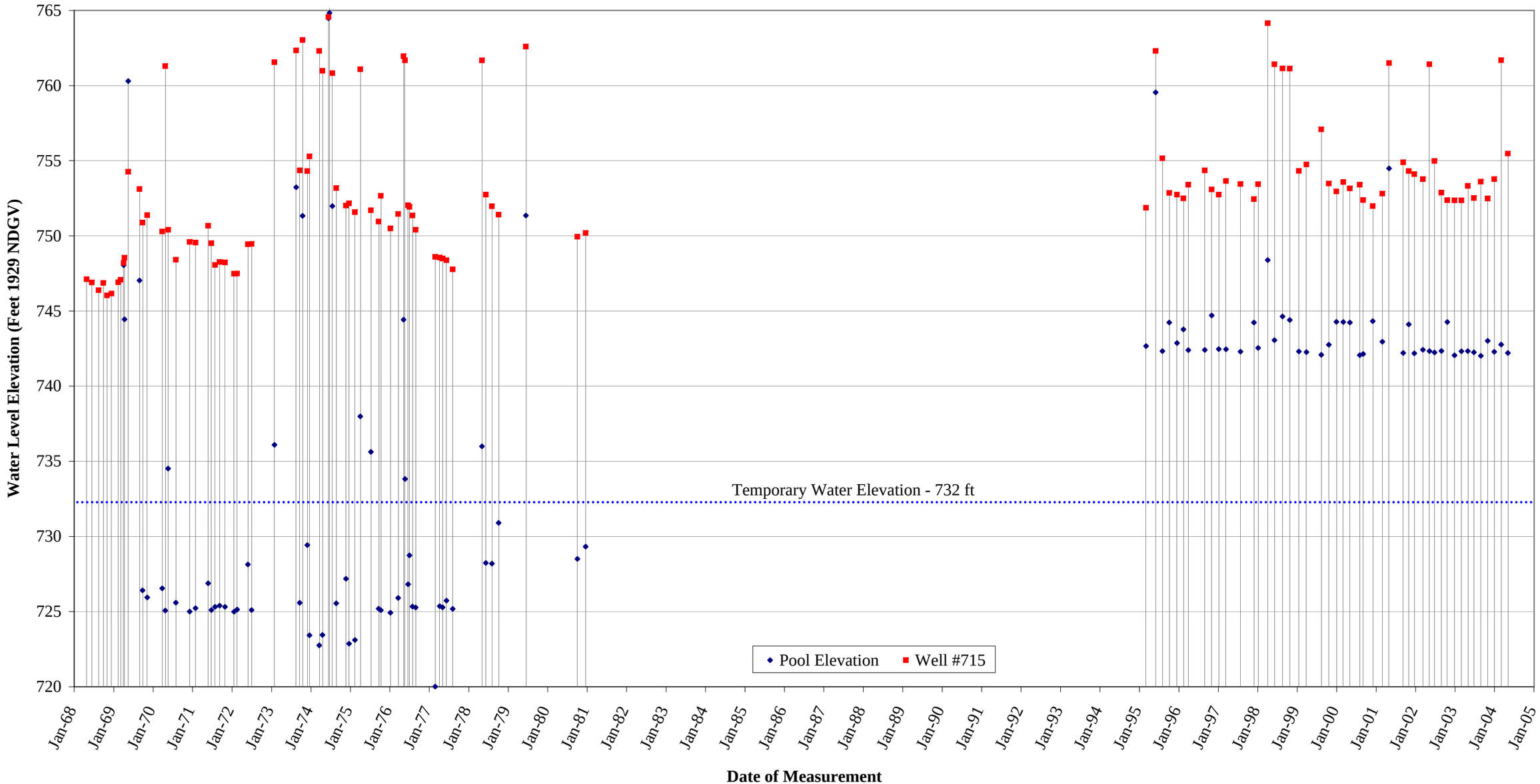
Upper Red Rock GW Well Data
Well #312



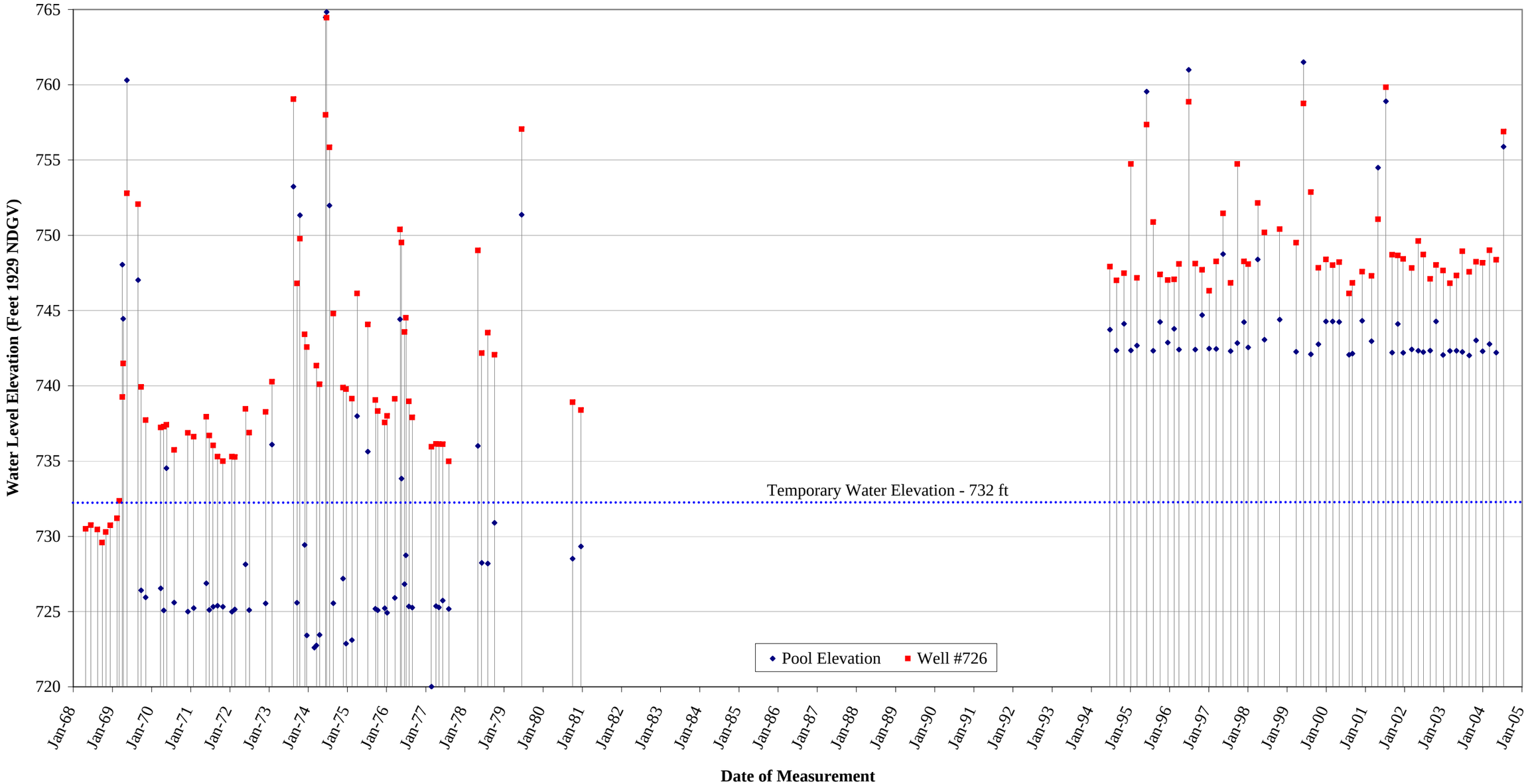
Upper Red Rock GW Well Data
Well #443



Upper Red Rock GW Well Data
Well #715



Upper Red Rock GW Well Data
Well #726



Upper Red Rock GW Well Data
Well #879