Ground Water Quality Technical Report No. 25

The Ramsey Channel of the Spokane Valley-Rathdrum Prairie Aquifer

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Cover photo: View to the west, showing a portion of the Rathdrum Prairie, in the foreground, with Hauser Lake (Idaho) on the right and Newman Lake (Washington) on the left.

Abstract

This report represents the findings from a study that suggests the presence of a saturated zone, herein designated as the *Ramsey channel*, within the northern portion of the Spokane Valley-Rathdrum Prairie aquifer (SVRPA). Study data supporting the existence of the channel include a bedrock contour map and five geologic cross sections prepared using data from 71 wells. The Ramsey channel area is not included into the aquifer boundary and thus has less stringent land use restrictions. Flow from this area is demonstrated to enter the SVRPA, thus resulting contamination may impact downgradient sole source users. This study indicates the need to administer the Ramsey channel area similar to the SVRPA and assess potential impacts from the Ramsey channel on downgradient users.

Introduction

The purpose of this study was to (a) delineate the lateral and vertical extent of a saturated zone, designated as the *Ramsey channel*, within the northern portion of the Spokane Valley-Rathdrum Prairie aquifer (SVRPA), and (b) discuss impacts the Ramsey channel may have on overall quantity and quality of ground water in the SVRPA, including the need for inclusion of the Ramsey channel within the boundaries of the aquifer.

Impact of Sole Source Designation on the SVRPA

The SVRPA (Figure 1; box shows area of study), which was designated a Sole Source Aquifer[1] in 1988 (Federal Register, 53 FR 49920, December 12, 1988), supplies potable water to the residents in Kootenai County, Idaho and the surrounding area of Spokane, Washington. Contamination to the aquifer could create a significant public health hazard, so regulatory requirements to ensure high water quality have been imposed.

Figure 1. Map showing the extent of the SVRPA (Modified from MacInnis, et al. 2000).

[1] "Sole Source Aquifer designations are one tool to protect drinking water supplies in areas with few or no alternative sources to the ground water resource, and where if contamination occurred, using an alternative source would be extremely expensive. " http://www.epa.gov/safewater/ssanp.html

Aquifer Boundaries in the Study Area: Current View and Limitations

Figure 2 shows the current boundaries of the aquifer, along with geographic features in the study area. The aquifer boundaries were established from a review of existing reports, surficial geology, and drillers' logs. The report "The Rathdrum Prairie Aquifer Technical Report" (DEQ, 1988) provided a review of ground water investigations conducted in the area up to 1988 and included a map showing the aquifer boundaries.

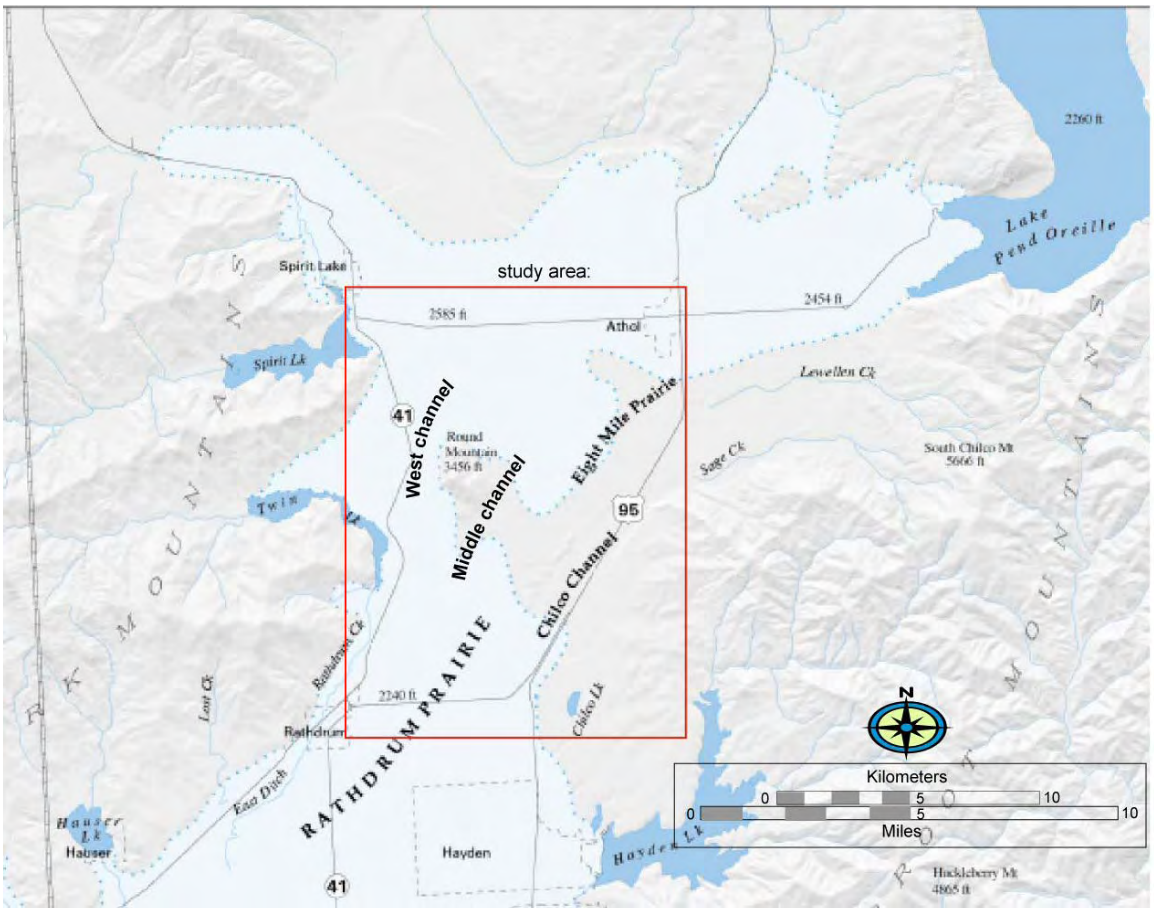

Figure 2. Current view of the northern portion of the Rathdrum Prairie Sole Source Aquifer, (Modified from MacInnis, et al. 2000).

General ground water flow is from the northeast to the southwest, with the major sources of recharge occurring in Idaho. Hammond (1974) concluded that ground water originating from Lake Pend Oreille and Spirit and Hoodoo Valleys moved through what was described as the *West channel*, the area between Round Mountain and Spirit Lake.

On the east side of Round Mountain, Hammond identified—in a test well located at T52N, R4W, 11AAB1[2]—what was thought to be bedrock at an elevation of approximately 2,063 feet above mean sea level (amsl). A test well drilled in the west channel, on the west side of Round Mountain, as part of the same study

[2] See Appendix 2 for a description of the well numbering system used in this report.

(T53N, R 4W, 28CAB1) did not encounter bedrock at an elevation of 1,971 feet. (The location of the east test well is shown on Figure 4, page 9.) Based on the reported shallow bedrock and shallow water level elevations in some wells east of Round Mountain, in the so-called "middle channel," it was assumed little ground water moved through this area (DEQ, 2000; DEQ, 1999; DEQ, 1988; USGS, 1988; PHD, 1977).

In addition, the present aquifer delineation excludes an area trending northwest, just south of the community of Athol (Figure 2). Hammond (1974, Figure 5) showed a buried bedrock surface 2000-foot contour extending to the northwest that indicated the area was underlain by a shallow bedrock ridge. Hammond believed the area did not contain saturated alluvium. However, he noted (page 8) that the buried bedrock surface configuration was not well defined below an altitude of 2000 feet due to a scarcity of wells and uncertain interpretation of geophysical (gravity) data collected for the study. Hammond (page 16) went on to state:

> "Thus, the total ground-water flow through the middle channel is assumed to be zero. This is of particular interest as prior investigators have assumed that most of the ground water from the Athol area moved to the southwest through this channel."

Aquifer Boundaries in the Study Area: Revised View and Implications

This study, conducted by DEQ on the middle channel area of the SVRPA southeast of Round Mountain, indicates that the channel contains a significant thickness of saturated alluvium. Herein designated the *Ramsey channel*, it trends roughly northeast-southwest and lies between Round Mountain and the western ridge that forms the western margin of the *Chilco channel* (Figure 3).

With respect to the area excluded from the aquifer delineation just south of Athol, driller's logs for several wells shown on Figure 4 (wells 47, 48, 63, 69, 72 and 77) indicate a saturated alluvial thickness, ranging from 50 to 100 feet. Shallow bedrock was not encountered in any wells in this area and, therefore, the aquifer is shown as a continuous unit throughout the area.

The revised SVRPA boundaries, based on results of this study, would include the Ramsey channel area and the area just south of Athol.

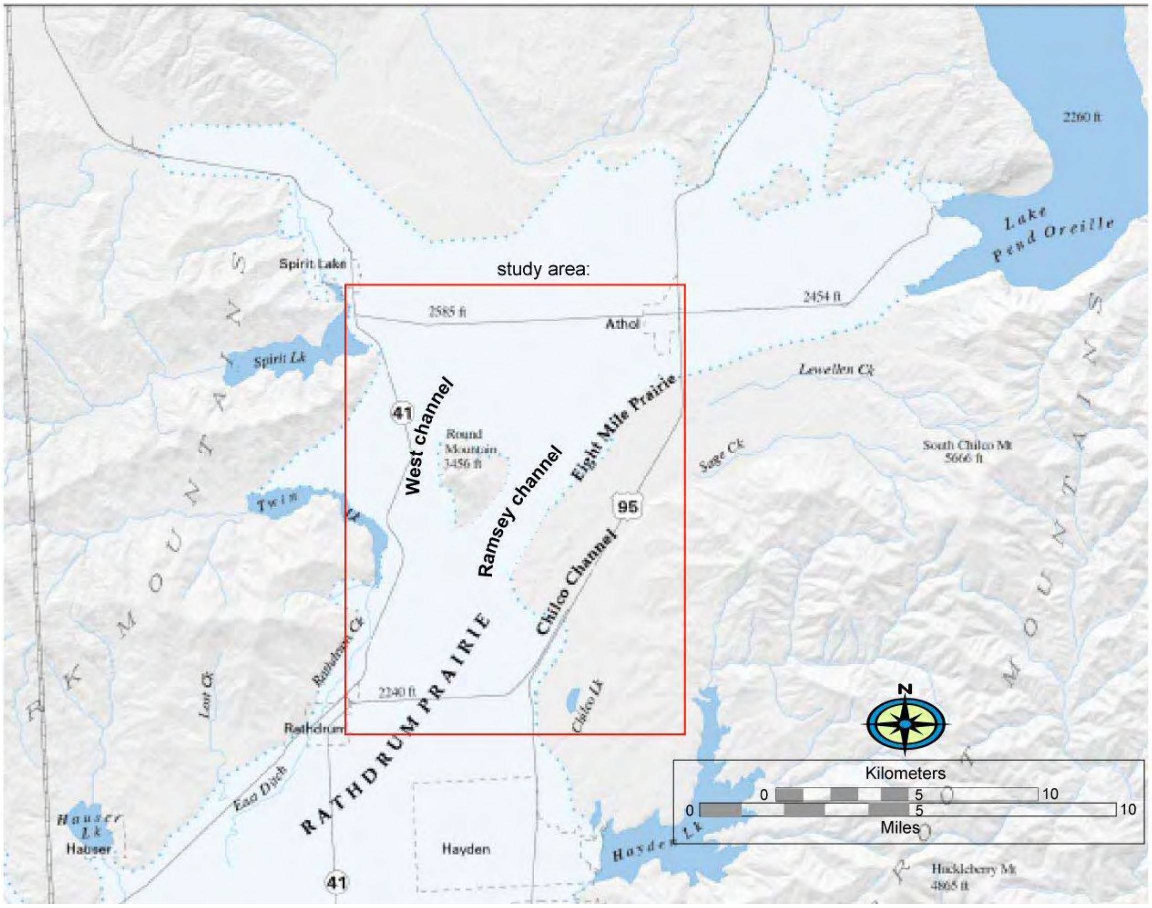

Figure 3. Revised view of the northern portion of the Rathdrum Prairie Sole Source Aquifer, (Modified from MacInnis, et al. 2000).

This new view of the boundaries of the aquifer may have important implications for land use activities. Previous investigations have considered the Ramsey channel a “no flow” area, so it was not officially incorporated into the boundary of the SVRPA presented in the Spokane Valley-Rathdrum Prairie Aquifer Atlas (DEQ, 2000; DEQ, 1999; DEQ, 1988; USGS, 1988; PHD, 1977). As a result, land use activities, such as housing developments, conducted within the Ramsey channel area have received less scrutiny than similar activities conducted over the recognized SVRPA.

The remainder of this report presents (a) a discussion of the hydrogeology of the study area, (b) a description of the methods used to determine the potential extent of the Ramsey channel, (c) the results of the study, and (d) the conclusions and recommendations drawn from the results.

Hydrogeology of the Study Area

The following summary of the geology and ground water flow of the study area is based on an Idaho Geological Survey (IGS) geologic map (Lewis, 2002), Idaho Department of Water Resources (IDWR) water well reports, and previous investigations conducted in the region (Adema, 1999; Graham and Buchanan, 1994; Hammond, 1974; Painter, 1993; Stevens, 2004; Thomas, 1963).

Extent and Description of the SVRPA

The SVRPA extends east and northeast from Long Lake, near Spokane Washington, to Lake Pend Oreille in northern Kootenai County, Idaho. In Idaho, the aquifer varies from 5 to 17 miles wide, covers approximately 283 square miles, and is bound on the eastern and western borders by mountainous terrain and numerous lakes (DEQ, 1988).

The geology of the Ramsey channel area is similar to that of much of the Rathdrum Prairie, consisting of scoured bedrock channels filled with sand and gravel flood deposits.

Bedrock in this area consists of granitic intrusive rocks, metasedimentary Belt Supergroup rocks, and extrusive basalt formations. Surface exposure of the bedrock units is limited within the delineated aquifer boundary as the flood deposits filled the pre-flood topography and created a relatively flat surface topography. The most prominent surface expression of the basement bedrock is Round Mountain, a steptoe of granite that is located near the center of the study area. For the most part, these rock units that form the bedrock of the area and the boundaries of the aquifer are generally low-yielding hydrogeologic units.

For the purposes of this study, the bedrock is simplified into two categories: basement complexes (granites and metasedimentary rocks) and basalt formations.

- **The basement complex** is formed of Precambrian metamorphosed sedimentary units (schist, gneiss, and shale) of the Belt Supergroup and intrusive granitic plutons emplaced during the Cretaceous/Tertiary time (DEQ, 1988).
- **The basalt formations** are part of the Columbia River Basalt Group extruded in Miocene time. The basalt formations have sedimentary interbeds, known as the *Latah Formation,* associated with this unit. The majority of the bedrock, both the basement complex units and basalt formations, have been removed by erosion during glaciation and a series of flood events. These flood events not only eroded and removed the basement rocks but reworked the glacial materials and deposited the sedimentary sequence that forms the present day SVRPA.

Flood deposits that overlie the bedrock units consist of sands and gravels deposited during the Lake Missoula flooding events of the Pleistocene (DEQ, 1988). These sediments are remnants of eroded bedrock and reworked glacial deposits placed as a series of high magnitude floods engulfed the area.

The floodwaters were derived from an ice dam that blocked the Clark Fork River, creating glacial Lake Missoula. Over time, the water of glacial Lake Missoula exceeded the strength of the ice dam and created catastrophic floods that released an estimated 500 cubic miles of water (Baker, 1973).

The floodwaters had tremendous velocities and carrying capacities that eroded and deposited a wide range of materials, ranging in size from large boulders (60 feet) to fine sands and silts (Baker, 1973). It is estimated that these flood events were repeated multiple times throughout the most recent Pleistocene glaciation, and these deposits that form the SVRPA have been shown, through geophysical investigations and well logs, to be hundreds of feet deep (Graham and Buchanan, 1994, Adema, 1999).

Due to the nature of the aquifer material, the SVRPA is known to be one of the most prolific aquifers of the United States (DEQ, 1988). The sands and gravels that make up the aquifer are highly transmissive, yielding high flow rates and volumes of ground water through the aquifer. Flow volumes through the aquifer have been estimated around 258 million gallons per day at the Idaho-Washington border, with a transmissivity estimate of up to 30,000 ft^2/day (McInnis et al., 2004).

Surface Expression of the Ramsey Channel

A line of evidence indicating the direction of floodwater movement through the Ramsey channel vicinity is the presence of a surficial gravel deposit on the southwest side of Round Mountain. This flood deposit, labeled Qgtl (gravel of Twin Lake, Lewis, et al. 2002), is present as a southwest sloping surface, found on the southwest side of the mountain at elevations ranging from about 2,700 feet down to about 2,400 feet on the valley floor. The gravel apparently was deposited on the lee, or the downstream, side of Round Mountain during the course of the numerous glacial Lake Missoula flood events.

The orientation of this material and its elevation above the main valley floor indicates that floodwater moving through this part of the valley flowed around both the northwest and southeast sides of Round Mountain. The mountain acted as an obstruction and forced the floodwater to diverge into two currents; sediment load in the converging floodwater dropped out behind the mountain. The northeast-southwest orientation of the deposit supports the notion that erosive forces acted on both the east and west sides of the mountain to create valleys or channels with similar dimensions. Both channels were subsequently backfilled with flood deposits.

Baker (1973) lists a high water mark at an elevation of 2600 feet at 52N, 03W, 17DD, just southeast of the community of Chilco (Figure 4). This feature, identified as the highest scabland found on the Columbia River Basalts found on the eastern side of the valley, would have to have been submerged by floodwaters for scouring to occur. Given that the gravel deposits on Round Mountain occur at an approximate elevation of 2700 feet, the actual high water mark in this area was probably greater than elevation of 2700 feet. The highest elevation of Round Mountain is 3,456 feet. If a minimum high water elevation of 2700 feet is used, 750 feet or so of the mountain stood above the floodwaters at some point during the flooding history. This obstruction diverted the floodwaters into two streams which converged downstream of the mountain.

Methods

The Ramsey channel study began during a source water delineation project conducted for a public water supply system located in the Ramsey (formerly middle) channel area. Approximately 50 feet of saturated alluvial material southeast of Round Mountain near the town of Ramsey, Idaho was identified from a driller's log for well #73. This prompted a review of other drillers' logs in the area.

Within the study area, approximately 200 drillers logs from Idaho Department of Water Resources files were reviewed to determine the extent of the Ramsey channel. From this list, 71 wells were selected for preparation of five geologic cross sections (Figure 4) and a bedrock contour map (Figure 5). The wells were selected to give an adequate coverage over the study area, to determine the saturated thickness, the local geology, and to provide the elevation of the bedrock-sediment contact. Lithologic descriptions on the drillers' logs were reviewed for consistency of aquifer properties.

Appendix 1 lists completion dates and well locations along with depth to water, total depth, and type of material in which the well was completed. Land surface elevations were determined by plotting well locations on USGS 7 1/2' quadrangles. Well locations on the drillers logs are listed to the nearest ¼, ¼ section (40-acre parcel). The locations listed on the drillers logs were used to approximate the locations of the wells used in this study and were not field checked with GPS coordinates. The central part of the Rathdrum Prairie is relatively flat, so the topographic relief across any 40-acre parcel is usually less than 20 feet. Land surface elevations are believed to be accurate to 20 feet.

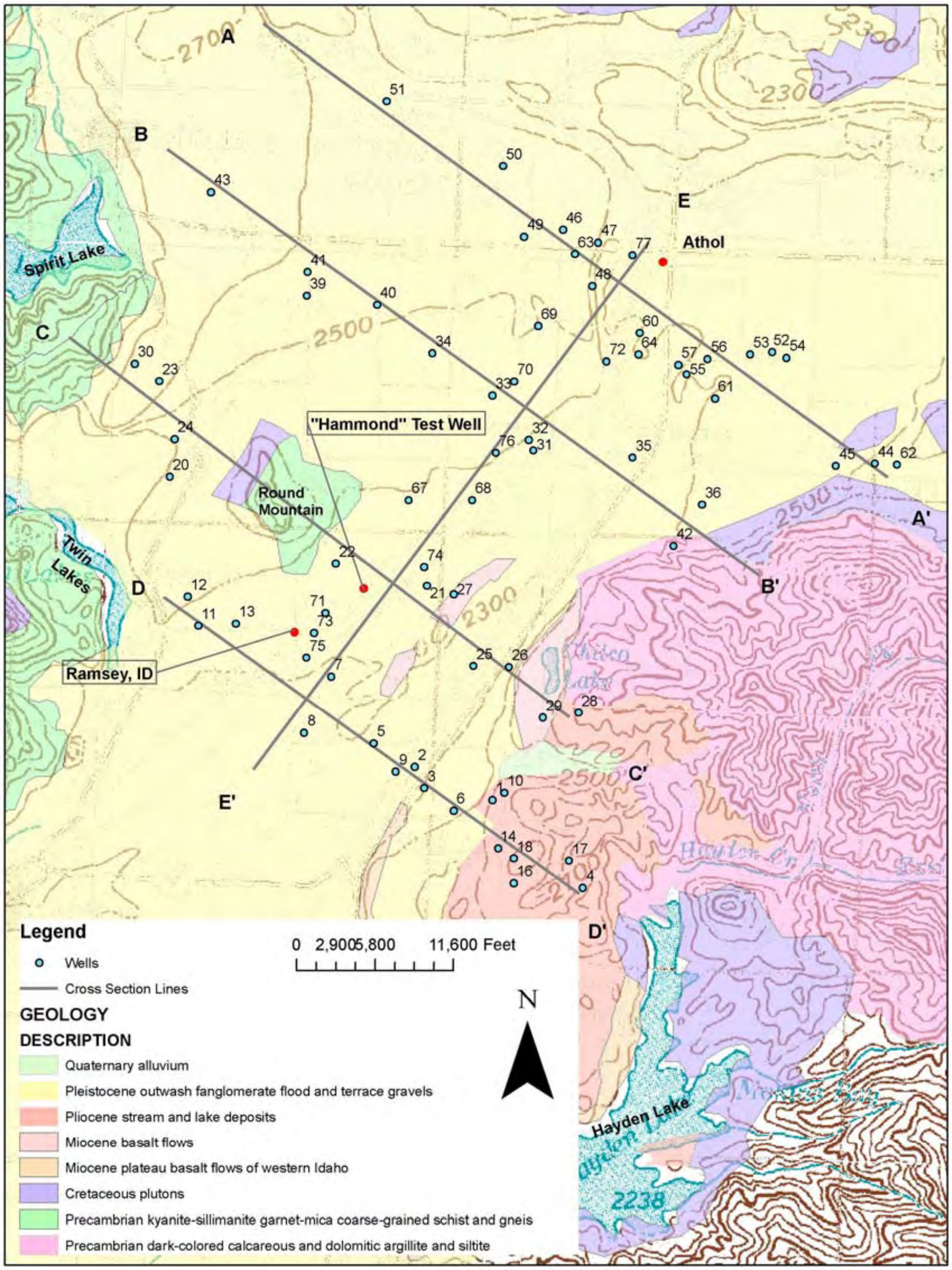

Figure 4. Map showing locations of the wells and cross sections used in this study.

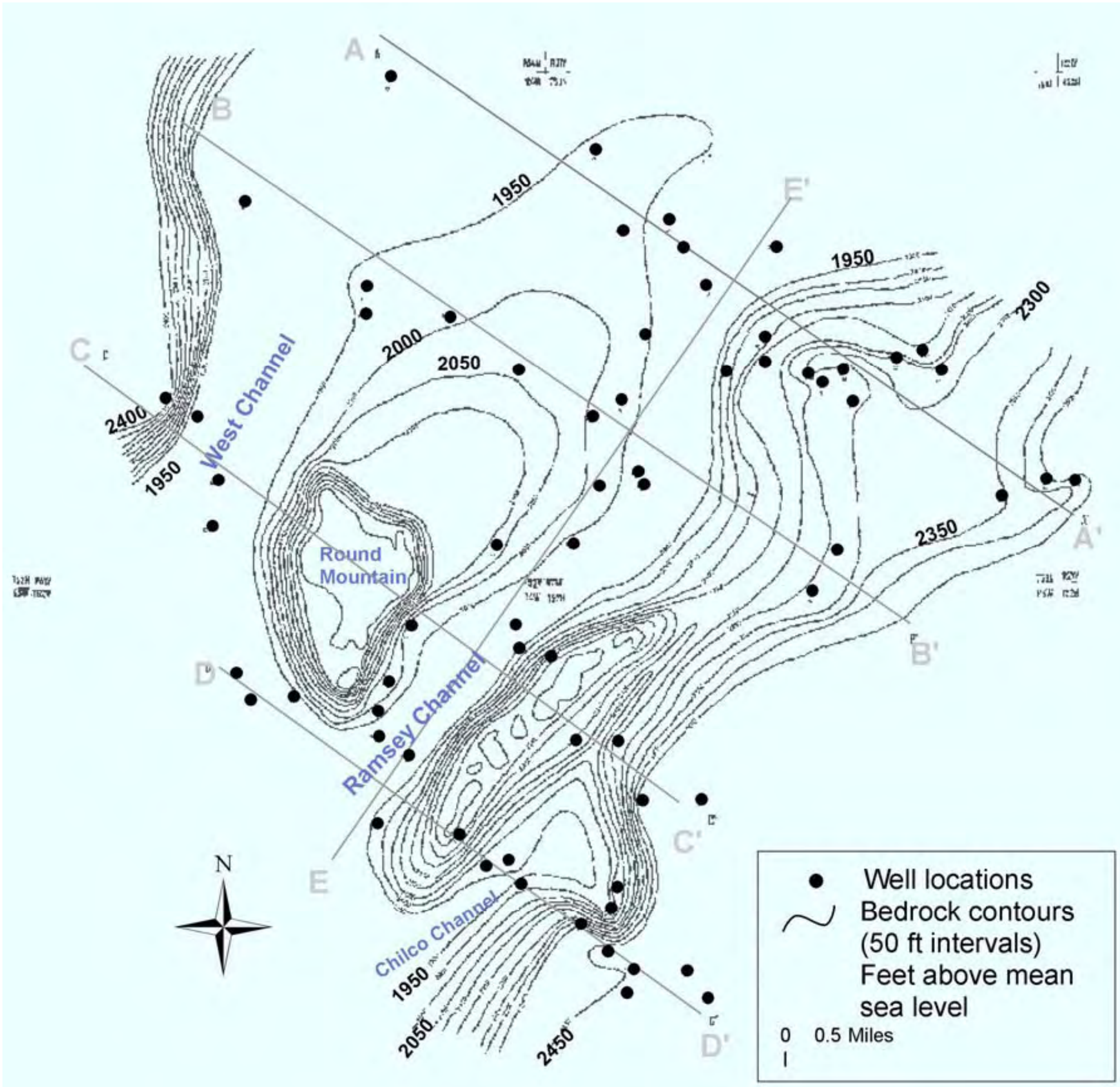

Figure 5. Bedrock Contour Map of the Ramsey channel Area.

Results

The results of the study are presented in this section, including a discussion of the bedrock contour map presented above and the five cross sections delineated in Figure 4. These are followed by brief discussions of the potential impact the Ramsey channel could have on water quality in the SVRPA and the impact the channel could have on existing ground water flow models, which have been constructed based on the *current* view of the aquifer rather than the *revised* view presented by this report

Bedrock Contour Map

The bedrock contour map (Figure 5) indicates the Ramsey channel is a significant hydrogeologic feature in this area. The map was prepared using the same 71 drillers logs used in the cross section preparation. Wells were plotted, and the elevation of the top of the bedrock formation was contoured where encountered. For the purposes of this map, bedrock was defined as any unit other than alluvial material. When bedrock was not encountered, the elevation corresponding to the bottom of the well was plotted and it was inferred that the bedrock contact was deeper than this elevation. For these particular wells, nearby wells that did encounter bedrock were used to control the inferred depth of the wells that did not reach bedrock. Inferred depths of these wells varied, depending on the available control points near each particular well and the depth at which the wells were completed.

Cross Sections

The locations of the cross sections are as shown on Figure 4. Four of the cross sections were oriented northwest-southeast, perpendicular to the southwesterly trending channel; the fifth cross section was oriented along the long axis of the channel. The cross sections are shown in Figures 4 through 8.

Cross Section A-A'

Cross section A-A' (Figure 6) shows a shallow bedrock upland mantled with approximately 100 to 200 feet of unsaturated alluvial material. This area is shown on the southeastern part of the cross section. In the middle and western part of this cross section, several wells penetrate saturated alluvium to 500 feet below ground surface (bgs). The water table elevation in these wells is generally in the range of 2,030 to 2,050 feet amsl, resulting in approximately 150 to 200 feet of saturated alluvium.

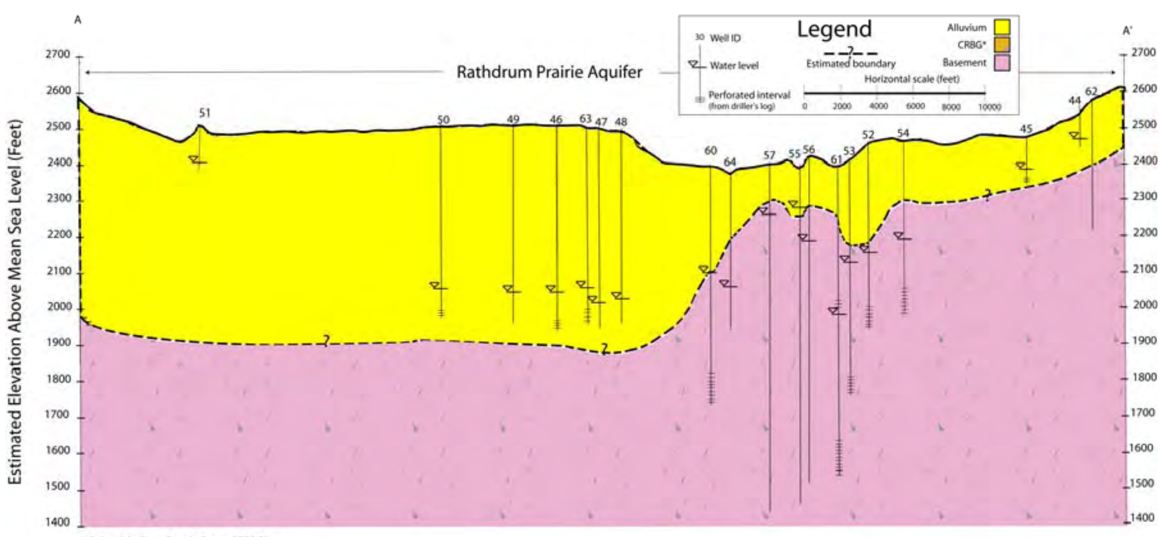

Figure 6. Cross Section A-A'.

Cross Section B-B’

Cross section B-B’ is shown in Figure 7. Water table elevations for wells in saturated alluvium generally range from 2,000 to about 2,050 feet amsl. Well 34 penetrated 25 feet of basalt from 409 to 434 feet below land surface. This basalt was underlain by 136 feet of blue, brown, and gray clay; the basalt/clay sequence may represent Columbia River Basalts underlain by sediments of the Latah Formation.

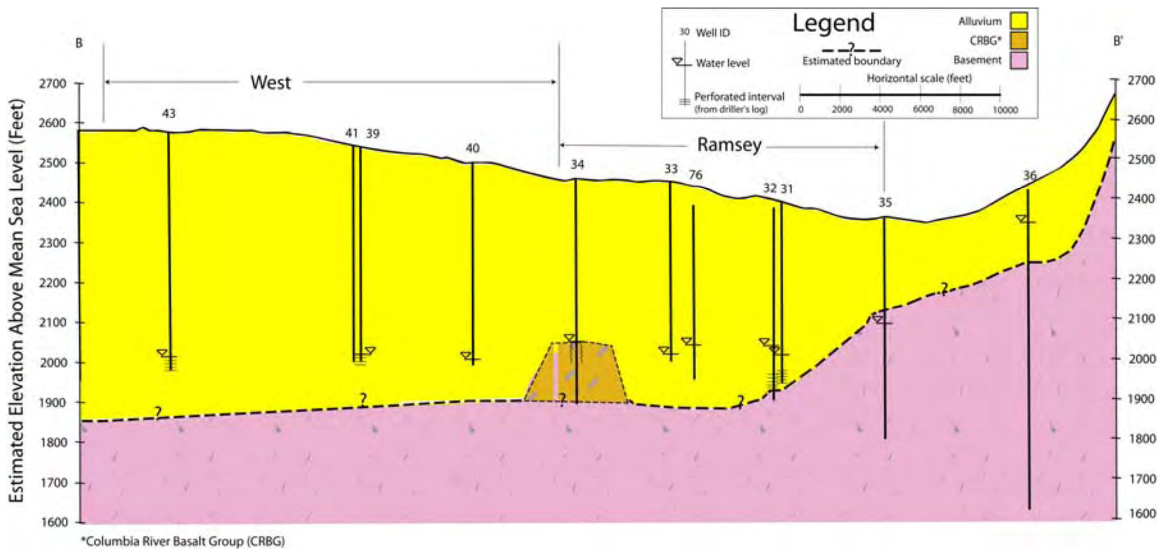

Figure 7. Cross Section B-B’.

Cross Section C-C'

Cross section C-C' is shown in Figure 8. This part of the Ramsey channel is constrained by Round Mountain on the west and the bedrock ridge on the east. Water table elevations in the two wells within the Ramsey channel shown on this cross section are estimated to be 2,030 and 2,055 feet amsl.

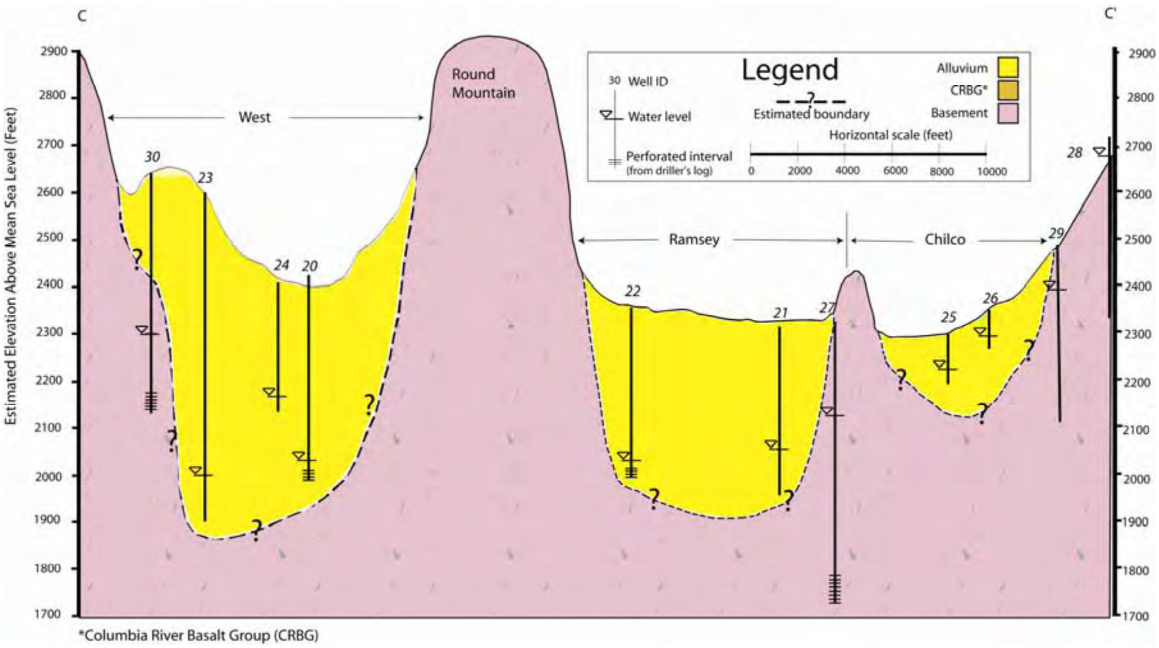

Figure 8. Cross Section C-C'.

Cross Section D-D'

Cross section D-D' (Figure 9) shows the Ramsey and West channels have merged into one broad channel. The Ramsey and Chilco channels are still separated by a bedrock ridge, expressed on the surface as Columbia River Basalt Group. The Chilco channel is wider and deeper at this location than along the C-C' transect, farther north. Water table elevations in both the Chilco and main SVRPA generally range from 2,000 to about 2,050 feet amsl.

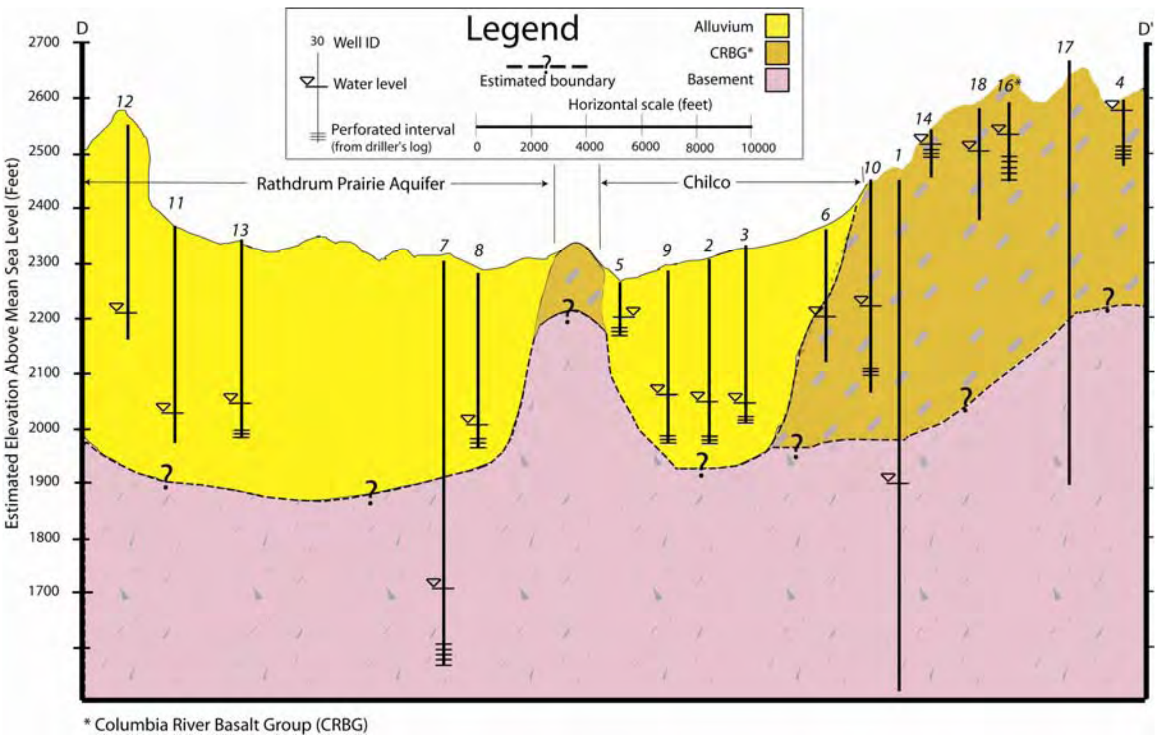

Figure 9. Cross Section D-D'.

Cross Section E-E'

Cross section E-E' is shown in Figure 10. This section depicts the longitudinal axis of the Ramsey channel. Four wells on this cross section encounter bedrock and can be viewed as control points on the estimated depth of the channel. The exact depth and shape of the channel could not be determined due to the limited data. Water table elevations in the channel range between 2,000 and 2,100 feet amsl, resulting in approximately 100 to 200 feet of saturated alluvium.

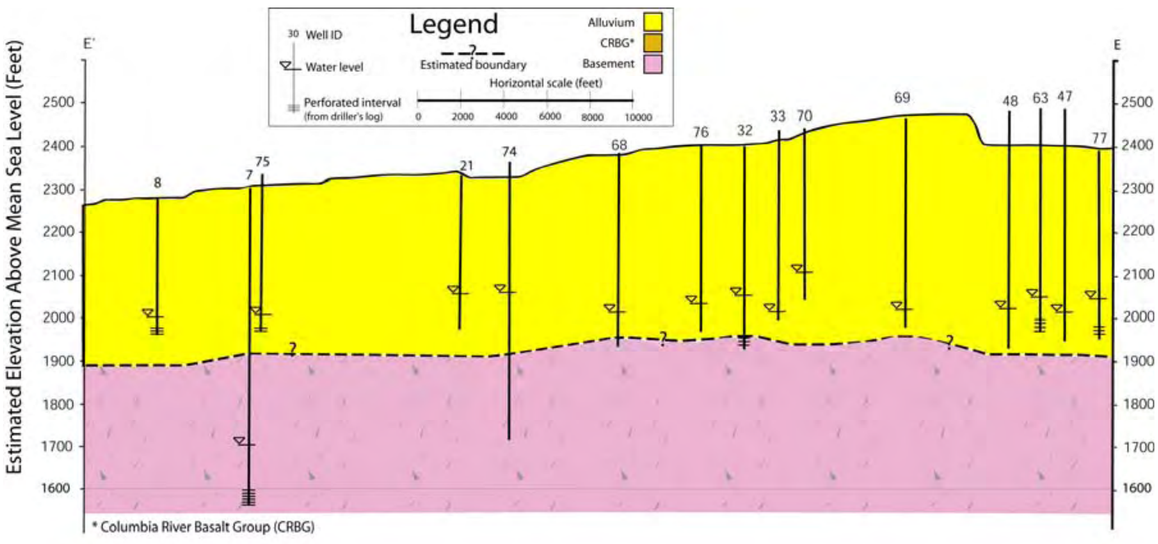

Figure 10. Cross Section E-E'.

Potential Impact of the Ramsey channel on Water Quality

Due to the limited data currently available, it was not possible to determine the saturated thickness of the aquifer in the Ramsey channel area. However, drill logs show approximately 35 feet of saturated alluvium near the margins of the channel and up to 200 feet near the axis of the channel. Because of the high productivity of the aquifer, production wells generally do not need to be drilled through the entire thickness of the aquifer in order to obtain adequate amounts of water. Only a few wells have penetrated through the entire alluvium to bedrock, and these wells are generally located along the margins of the aquifer. In the southern part of the Rathdrum Prairie, from the Washington-Idaho border east to Coeur d'Alene, Adema (1999) reported maximum aquifer thicknesses ranging from 710 to 1,170 feet, based on gravity measurements.

Initial estimates based on the dimensions of the saturated portion of the channel, water level elevations, and published hydraulic conductivity values for the SVRPA indicate that the flow through the Ramsey channel may be a significant feature of the northern portion of the SVRPA. To adequately determine the approximate flow volumes, the exact areal extent, saturated thickness, and hydraulic gradient of the channel must be identified and described.

Due to the high permeability of the sediments that form this aquifer, there is great potential for any introduced contaminants to rapidly migrate into the ground water. Contamination in the northern portions of the aquifer could result in measurable impacts down-gradient.

Currently, the Ramsey channel is not incorporated into the official SVRPA boundary, resulting in less stringent regulations imposed on septic systems, development, industry, and transportation projects in this rapidly developing area. If recent development in the Ramsey channel area may significantly impact the main aquifer, then incorporation of the channel into the SVRPA would be proposed.

Included among the issues of concern are the following:

- Private residents are constructing homes at less stringent spacing intervals. These homes are being constructed with onsite wastewater treatment systems, which, over time, have the potential to further elevate nitrate concentrations in the ground water. (Previous investigations have identified private septic systems in areas without sewers as a major source [60% of total] of contamination to the aquifer [DEQ, 1999]).
- To the north and directly up-gradient of the Ramsey channel, a large theme park is thriving, and an expansion of the park is proposed over the next few years. Wastewater at the theme park is currently treated with a number of onsite septic systems that have the potential for introducing contaminants to the aquifer; park expansion could introduce greater quantities of contaminants to the aquifer.

Potential Impact on Conceptual/Numerical Models

Several numerical models have been constructed to model the ground water flow and quality through the SVRPA (Buchanan, 2000; Clarkson and Buchanan, 1998; Painter, 1993; Bolke and Vaccaro, 1981). These models have been constructed based on the current conceptual model of the aquifer, which does not include the Ramsey channel. In the area of the Ramsey channel, these models will need to be updated to incorporate the new conceptual conditions through this channel.

Conclusions and Recommendations

The areal extent of the saturated Ramsey channel identified in this study is based on five cross sections and a bedrock contour map generated from existing drillers logs and historical reports. This evaluation indicates that significant saturated alluvium (up to 200 feet) exist with the Ramsey channel area.

As a result, the Ramsey channel has the potential to impact the overall conceptual model of the SVRPA. A more detailed evaluation of the saturated thickness will be required to determine the potential contributions of the Ramsey channel to flow and potential ground water quality impacts to the SVRPA.

This study strongly suggests that the Ramsey channel and an area just south of Athol have been overlooked as significant features within the SVRPA. Therefore, incorporation of these areas into the SVRPA designation should be evaluated at this time.

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APPENDIX 1 — Well Information

Well Number	Installation Date	Location	Elevation (ft amsl)	Depth to Water (ft bgs)	Well Depth (ft bgs)	Aquifer (G -- Granite; A -- Alluvium; B -- Basalt)	Depth to top of open interval (ft bgs)	Bedrock Elevation (ft amsl)
1	1/12/1985	52N 03W 19 DD	2448	550	1000	G	510	1953
2	3/8/1985	52N 04W 24 CA	2305	250	335	A	325	1970*
3	10/29/1986	52N 04W 24 AD	2330	276	332	A	317	1998*
4	6/18/2002	52N 03W 18 CC	2595	17	120	B	80	2577
5	4/16/1980	52N 03W 24 BB	2265	65	97	A	92	2168*
6	7/8/1982	52N 03W 19 DC	2380	180	260	B	232	2228
7	4/4/2001	52N 04W 14 AB	2305	600	740	G	700	1920
8	4/5/1996	52N 04W 14 CC	2280	278	313	A	300	1962*
9	7/6/1984	52N 04W 24 DB	2285	220	320	A	310	1965*
10	10/12/1983	52N 03W 19 AD	2450	225	385	B	349	2065*
11	12/16/1996	52N 04W 9 CC	2360	335	400	A	400	1960*
12	8/22/1997	52N 04W 9 AB	2555	350	400	A	400	2155*
13	12/20/2002	52N 04W 10 CB	2340	298	356	A	348	1981*
14	11/29/1980	52N 03W 30 DA	2540	25	80	B	37	2505
16	9/7/2000	52N 03W 29 CC	2590	60	140	B	100	2486
17	3/11/1982	52N 03W 29 AD	2645	na	750	B	514	2531
18	7/2/1996	52N 03W 29 BC	2580	80	206	B	120	2462
20	9/20/2001	53N 04W 33 DB	2425	395	438	A	415	1987*
21	4/18/1984	52N 04W 1 CD	2315	260	360	A	357	1955*
22	1/28/1986	52N 04W 2 AC	2355	325	360	A	340	1995*
23	2/6/2001	53N 04W 29 AA	2600	600	700	A	700	1900*
24	6/15/1978	53N 04W 28 CC	2410	244	372	A	272	2138*
25	1988	52N 03W 7 DC	2297	76	107	A	105	2194
26	3/13/2003	52N 03W 7 DD	2350	55	82	A	82	2268*
27	10/19/1996	52N 03W 6 CC	2325	200	600	G	540	2298
28	4/13/1987	52N 03W 17 AD	2720	40	379	G	47	2674
29	8/26/1984	52N 03W 17 BC	2490	95	380	G	380	2488
30	12/11/1993	53N 04W 20 CD	2640	342	510	G	500	2408
31	12/7/1992	53N 03W 29 CC	2392	381	447	A	447	1945*
32	4/28/1994	53N 03W 29 CC	2400	344	470	A	464	1936
33	12/11/1968	53N 03W 30 AB	2442	425	446	A	446	1996*
34	1/1/1969	53N 04W 24 DA	2455	409	570	B	570	2046*
35	3/9/1976	53N 03W 28 CD	2320	265	550	G	435	2099
36	10/24/1996	53N 03W 34 DB	2430	80	800	G	178	2263
39	6/28/1994	53N 04W 15 DD	2540	524	563	A	522	1977*
40	5/15/1996	53N 04W 14 DD	2490	473	499	A	499	1993*
41	11/2/1979	53N 04W 15 AD	2540	na	550	A	520	1990*
42	8/15/1975	52N 03W 3 BB	2425	160	300	B	165	2265
43	12/12/1974	53N 04W 9 AC	2580	558	600	A	600	1980*
44	10/25/1983	53N 03W 25 DD	2540	86	100	A	100	2440*
45	6/13/2003	53N 03W 25 DC	2460	85	120	A	112	2340*
46	3/15/2000	53N 03W 8 DD	2500	461	560	A	538	1940*
47	6/21/2001	53N 03W 8 DD	2490	475	542	A	542	1948*
48	4/22/2002	53N 03W 17 DA	2485	460	520	A	520	1965*
49	1/16/1986	53N 03W 7 DD	2500	460	535	A	523	1965*
50	8/23/2000	53N 03W 6 CD	2500	450	518	A	500	1982*
51	9/26/1980	53N 04W 2 BB	2510	105	126	A	126	2384*
52	3/26/1999	53N 03W 23 DC	2440	285	500	G	440	2171
53	2/17/2000	53N 03W 23 CB	2460	285	642	G	602	2225
54	9/15/1997	53N 03W 23 BD	2450	260	468	G	395	2297
55	9/10/1997	53N 03W 22 CC	2390	120	925	G	135	2255
56	4/28/1996	53N 03W 22 AC	2420	233	900	G	137	2283
57	3/13/1996	53N 03W 22 BC	2385	145	985	G	100	2290
60	9/7/1993	53N 03W 21 BA	2380	290	660	G	560	2091
61	6/6/1997	53N 03W 22 CD	2380	400	845	G	360	2250
62	8/11/1979	53N 02W 30 CC	2580	na	350	G	178	2402
63	7/19/1995	53N 03W 17 BA	2490	440	520	A	490	1920*
64	1/23/1997	53N 03W 21 CA	2360	310	420	G	182	2185
65	4/4/1994	54N 04W 35 DB	2470	300	416	A	395	2054*
67	2/26/1985	53N 04W 36 AC	2385	na	415	G	370	2074
68	9/14/1980	53N 03W 31 AC	2375	358	440	A	405	1938
69	6/7/1983	53N 03W 20 BB	2470	450	490	A	481	1980*
70	8/9/1977	53N 03W 14 DD	2430	327	387	A	275	2043*
71	10/30/1969	52N 04W 11 BB	2310	na	318	G	245	2025
72	9/18/1995	53N 03W 21 BC	2410	140	675	G	320	2160*
73	12/7/1995	52N 04W 11 BC	2320	315	377	A	310	1956
74	6/12/1993	52N 04W 1 DA	2360	300	645	G	494	2020
75	4/16/1984	52N 04W 11 CC	2320	300	350	A	340	1970*
76	9/26/1990	53N 03W 30 CD	2405	370	434	A	403	1971*
77	10/19/1987	53N 03W 16 BA	2390	341	440	A	410	1950*

* Indicates bedrock was not encountered at completion depth

APPENDIX 2 — Well Numbering system