Preliminary Hydrogeologic Analysis of Fraser Plateau, Clearwater County, Idaho

John A. Welhan

Staff Report 09-1
April 2009

Idaho Geological Survey
Morrill Hall, Third Floor
University of Idaho
Moscow, Idaho 83844-3014

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SUMMARY

An evaluation of local geology and subsurface geologic information obtained from 41 drillers' logs was undertaken at the request of local residents on the Fraser plateau, a 40 km^2 area of the Columbia River Basalt (CRB) plateau in southernmost Clearwater County, Idaho. Unlike other parts of the CRB aquifer, wells in the Fraser plateau are characterized by low yields (<20 gallons per minute), with half being dry holes. Based on drillers' descriptions of lithology and the ubiquitous accounts of pervasive saprolitic weathering in CRB rocks, it is likely that bulk permeability has been reduced by plugging with saprolitic material.

The aquifer is characterized by at least three zones of "basalt" separated by weathered materials: an upper basalt zone whose base averages 107 feet below land surface (bls); an intermediate zone, whose mid-point averages 218 feet bls; and a deep zone, whose top averages 386 feet bls. Water was encountered in all intermediate and deep basalt zones during drilling. Wells that were reported as "dry" are open to the aquifer over intervals averaging 436 ft (σ = 72 ft); in contrast, actively producing wells are open over an average of 164 ft (σ = 137 ft). Eighty per cent of water-bearing zones occur at depths shallower than 350 ft.

Depths to static water recorded by drillers in 20 active wells correlate with drilled depth (r^2 = 0.90) and indicate that the aquifer comprises a single water-bearing unit with multiple zones of preferential water flow. A number of factors indicate that development of this ground-water resource should be undertaken with caution. Regardless of the sources and rates of recharge, this aquifer has very limited capacity to deliver water to wells. Future development that targets the upper 350 feet of the aquifer should proceed only after a thorough investigation of the recharge source(s), rates of supply, and long-term safe yield of the aquifer, in order to avoid injury to current well owners' diversion rights.

INTRODUCTION

BACKGROUND AND SCOPE

In response to a proposed development on the Fraser plateau, residents there contacted the IGS for information on ground-water conditions that might help inform on the feasibility and potential impact of proposed community extraction wells that would tap the aquifer on which current users rely. The issue was evaluated from a technically neutral perspective in order to be able to advise all parties about what is known of the hydrogeologic situation and the possible implications for future development in advance of a public hearing to be held by the Idaho Department of Water Resources in mid-2009.

HYDROGEOLOGIC SETTING

The study area is located in the southern portion of the Rudo 7.5' (1:24,000 scale) quadrangle in Clearwater County, Township 35N Range 03E, where rocks of the Columbia River Basalt (CRB) Group have been incised to form a plateau bounded by two canyons: Jim Ford Creek on the north and Lolo Creek on the south (Figure 1). Ground water in these rocks typically is hosted in the porous and permeable basalt zones between lava flows that are themselves separated by thick zones of massive, columnar-jointed basalt that act as a barrier to vertical water movement (Boguslawski and others, 2003). Unlike other aquifers hosted in rocks of the CRB, however, wells drilled in the Fraser plateau have very low yields, and a very large proportion of drilled wells are dry.

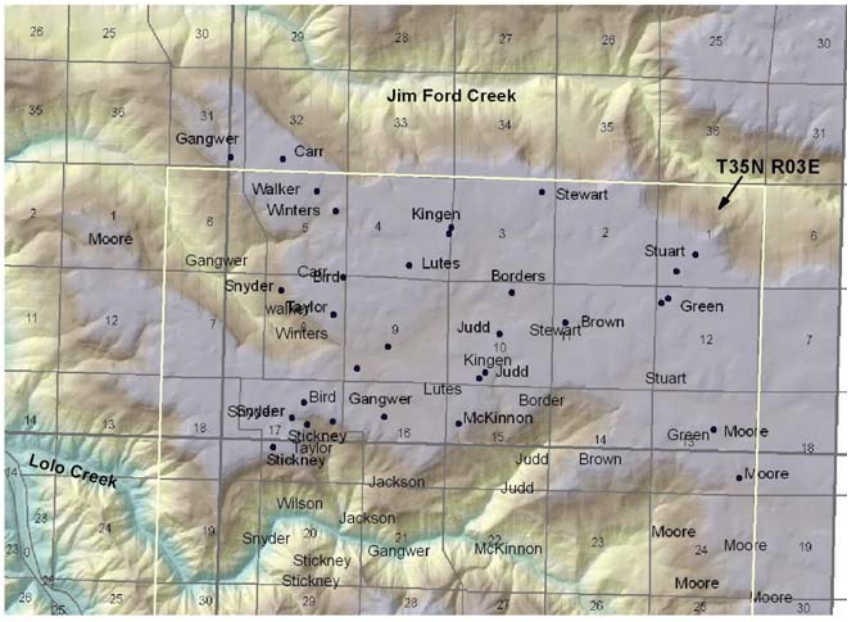

Figure 1. Shaded relief map of the area of interest, indicating wells that were used in this study. The southern boundary of the Rudo 1:24,000 quadrangle runs through the middle of Township 35N, Range 03E (Sections 13-17).

SOURCES OF INFORMATION

This analysis is based on recent geologic mapping by the IGS in the Rudo quadrangle (Lewis and others, 2005) that helps to define the geologic framework of this specific aquifer, as well as on 41 drillers' logs obtained from the Idaho Department of Water Resource's (IDWR) searchable on-line database (IDWR, 2008a; Appendix A) and a well location database maintained by that agency (IDWR, 2008b). Ms. Norma Brand, an area resident, provided a location map indicating which of the area's wells had been drilled dry vs. those that are active producers. Because of her local knowledge of the area, this information was considered to be the most accurate for constraining well locations and her map was used to correct the well locations reported on the drillers' logs (Appendix B).

DATA ANALYSIS

DRILLERS' LOGS

For this preliminary evaluation, the exact location of the wells was unnecessary, as long as they were completed in, and represent, rocks of the Fraser plateau aquifer. Of 41 IDWR well logs that were available, 14 appeared to be mislocated relative to Ms. Brand's map. Ten were mislocated at a Q or QQ section level and four, at the Township level. The adjusted well locations, showing the approximate amount of offset, are summarized in Figure 2.

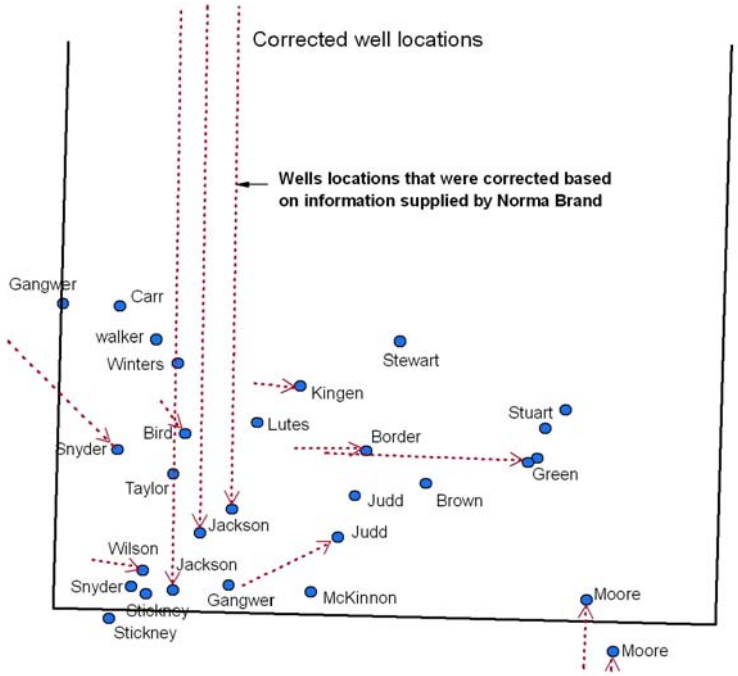

Figure 2. Corrected locations of wells analyzed in this report, showing the amount of offset from locations indicated in drillers' logs. The perimeter outline represents the southern Rudo 1:24,000 quadrangle.

Well log information was downloaded from the IDWR web site, compiled in a spreadsheet, and sorted. Ten records were discarded either because (i) the well's lithology clearly placed it outside the study area, (ii) the location could not be confirmed based on information supplied by Ms. Brand, or (iii) the well was too shallow (<80 feet) to provide useful subsurface information.

Information extracted from the driller's logs included: drilling depth, yield, lithology, static water level, open interval(s), static water level, and depth at which water was encountered during drilling (See Table A.1, Appendix A). Lithologic descriptions that were believed to represent basalt or weathered basalt (e.g., "black shale," "black sand," and variously colored "clay") were interpreted as "basalt." All depths to basalt provided in this report are unadjusted for differences in land-surface elevation among the wells; however, because the study area is essentially a horizontal plateau, the unadjusted depths provided an adequate sense of subsurface stratigraphy for the purpose of this analysis.

HYDROGEOLOGIC FRAMEWORK

A portion of a geologic map of the area is shown in Figure 3 (from Lewis and others, 2005), showing a succession of Tertiary-age Columbia River Basalts in the area of Fraser plateau capped by the youngest basalt unit (Tcsc) and underlain by Mesozoic-age crystalline metamorphic basement rocks (Mz). The Latah Formation (Tli) is a sedimentary unit interbedded with thin basalt flows that is geographically discontinuous across the Rudo quadrangle and that may or may not be present beneath the Fraser plateau; its nearest surface exposure is on the north side of Jim Ford Creek canyon. Figure 4 depicts subsurface geology along a cross section approximately two miles north of the plateau (after Lewis and others, 2005) and summarizes the local stratigraphy, relative ages of the mapped rock units and their general thicknesses. All wells in this study were completed in bedrock and are consistent with a horizontally layered sequence of basalts, as inferred from geologic mapping (Figure 4)

Basalt comprises most if not all of the subsurface beneath the plateau (at least to depths of the order of 1000 ft), but drillers' logs record remarkably little actual "basalt," particularly in the upper 200-300 feet. Instead, many of the air-rotary drilling records are characterized by lithologic descriptions such as "clay," "sand" or "shale" of various colors. Near-surface weathering of the CRB Group is known to produce characteristic red-orange or red-brown saprolites that could easily be mistaken for, and described as, a "sedimentary" lithology. For example, Lewis and others (2005) state that the youngest Tcsc unit characteristically weathers to saprolite, and similar degrees of chemical weathering are seen in older CRB units in the area. Drill cuttings derived from these weathered basalts also commonly have a friable, "shale-like" appearance (J.D. Kauffman, written comm., 2008). If such alteration is indeed pervasive in the CRB rocks beneath the Fraser plateau, then it would explain the textures and colors that appear in most of the lithologic descriptions. Furthermore, it would explain why well yields on the Fraser plateau are so low: Much of the aquifer has experienced a reduction in permeability due to plugging of its water-bearing zones with saprolitic material.

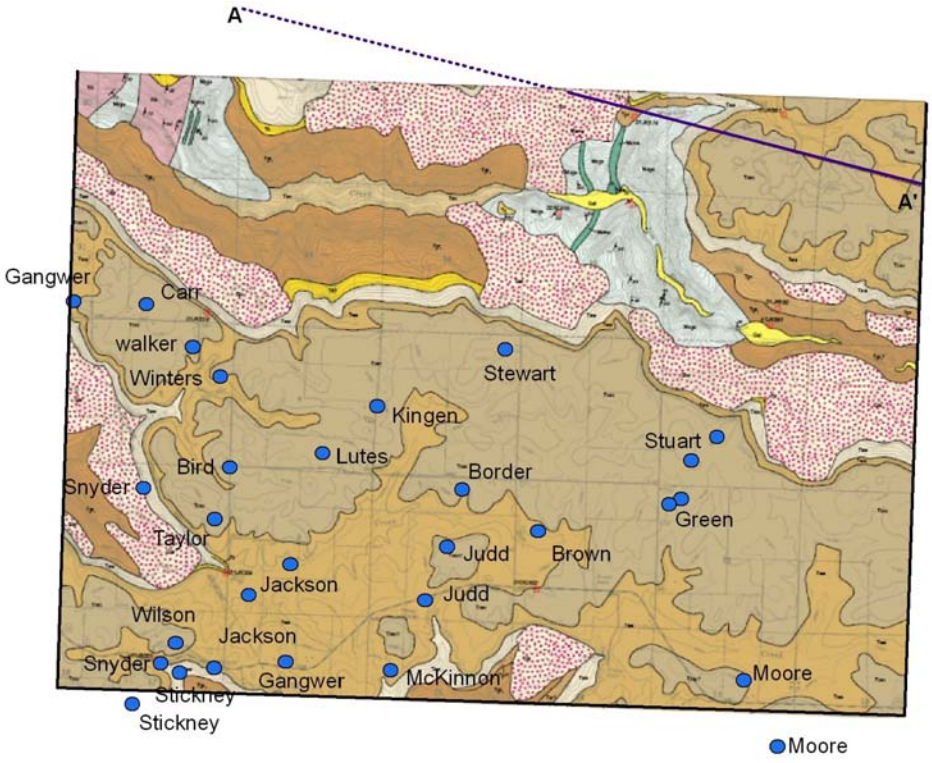

Figure 3. Geology of the southern Rudo 1:24,000 quadrangle, from Lewis and others (2005).

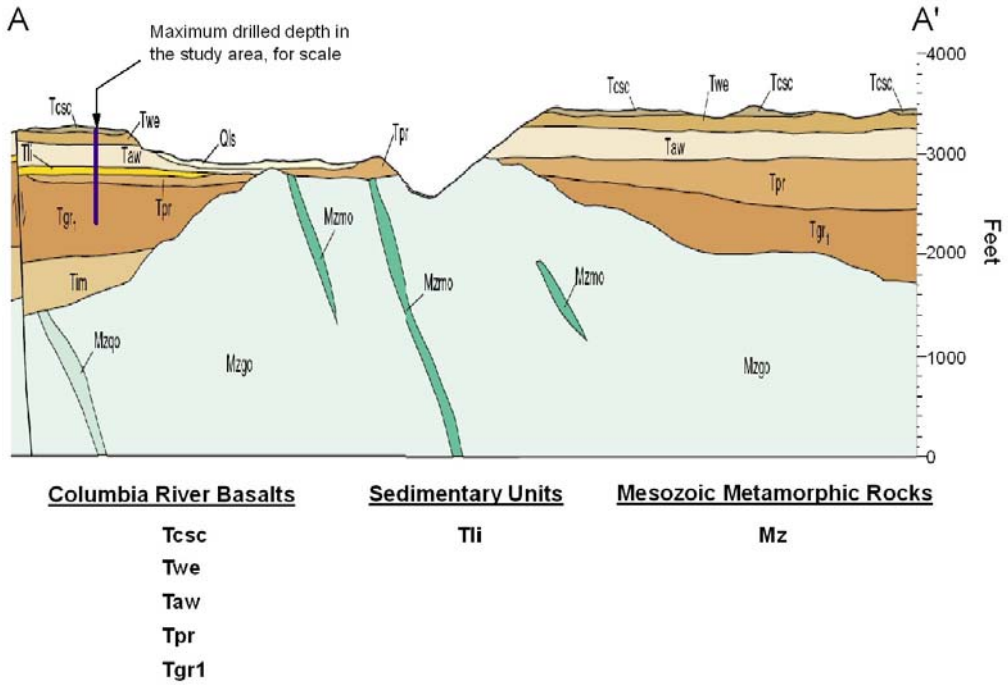

Figure 4. Nearby geologic cross-section (A-A', in Figure 3), showing relative ages and general thicknesses of basaltic units that underlie the Fraser plateau.

RESULTS AND DISCUSSION

BASALT STRATIGRAPHY

Ninety-five occurrences of basalt or weathered basalt were reported in 41 wells, at depths ranging from land surface to 950 feet bls, the maximum drilled depth. At least three different basalt zones were noted: all three were encountered in 11 of 41 wells, and two of the three zones were encountered in 22 wells. The proportion of dry and active wells that encounter these basalt zones is statistically indistinguishable, indicating that subsurface geology beneath the Fraser plateau is uniform and not a primary factor affecting well performance.

Figure 5 summarizes the depths of the basalt zones that were identified. Average depth to the base of the upper basalt zone is 107 ft (N=35); the average mid-point of the intermediate basalt zone is 218 ft (N=30) below surface; and the top of the deep basalt zone lies at an average depth of 386 ft (N=18).

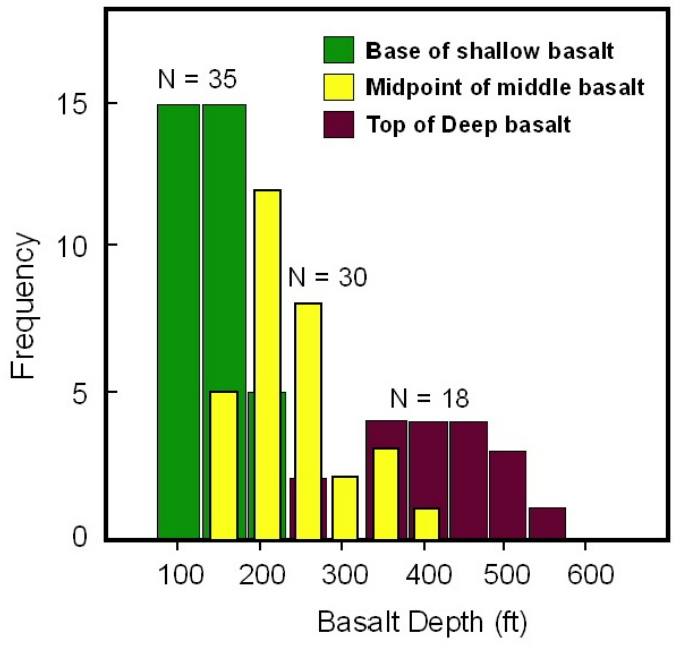

Figure 5. Distribution of depths at which basalt zones were encountered in wells.

WELL-AQUIFER COMMUNICATION

The mean drilled depth in 21 dry wells is 466 ft (σ = 152 ft); and in 24 active wells, 393 ft (σ = 205 ft). A Mann-Whitney test of similarity between the two groups returned a p-value of 0.025, indicating that, at 95% confidence, the active wells have been drilled to significantly shallower depths than the dry wells.

An analysis of the wells' open intervals (the zones over which the wells communicate with, and draw water from, the aquifer) revealed an even more striking and statistically significant difference between dry and active wells: the open intervals in wells reported as "dry" averaged 436 ft (σ = 72 ft) in length compared to 164 ft (σ = 137 ft) in the actively producing wells (Figure 6). Most importantly, actively producing wells appear to tap a shallower water source over a smaller open interval, with over 80% spanning zones shallower than 350 ft. More than 50% of active wells derive their water from zones shallower than 250 ft; in contrast, 50% of dry wells are in communication with the basalt formation over more than 500 ft.

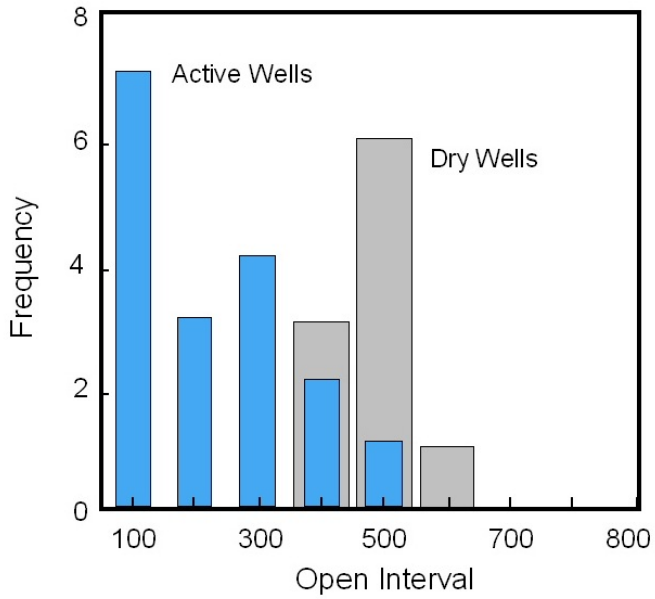

Figure 6. Frequency of occurrence of open intervals in dry and active wells.

Only 4 of 19 wells that encountered the upper basalt zone reported water from that zone; in contrast, water was encountered in all intermediate and deep basalt zones. Regardless of depth, the occurrence of water was highly localized, with yields of only a few gallons per minute in all instances.

WELL YIELD AND STATIC WATER LEVELS

Half of all wells drilled on the Fraser plateau encountered no water, and the yields of all actively producing wells are low, ranging from 0.25 to 20 gpm. From the drillers' logs, it is unclear how much or how consistently well development was conducted (e.g., extended pumping, surging, or step-testing) and if it improved well yields. The yields of wells that reported having conducted some sort of extended pumping (> 1 hour) were no higher than in wells without any indication of post-drilling development.

Figure 7 summarizes static water levels (feet bls) that were recorded in the 20 active wells at the time of well completion. Depth to static water increases at a rate of about 8 ft per 10 ft of drilled depth ($r^2 = 0.90$). A slope of less than 1:1 indicates that this is a ground-water recharge area. From the drillers' logs, it appears that ground water issues from discrete, localized zones within the basalts; however, if these zones represented a series of perched aquifers, their static water depths would vary in a 1:1 ratio with drilled depth. Instead, the data indicate that the system behaves as a single aquifer within which ground water moves along multiple preferential flow zones that are probably located in the least weathered, fractured portions of the basalt sequence.

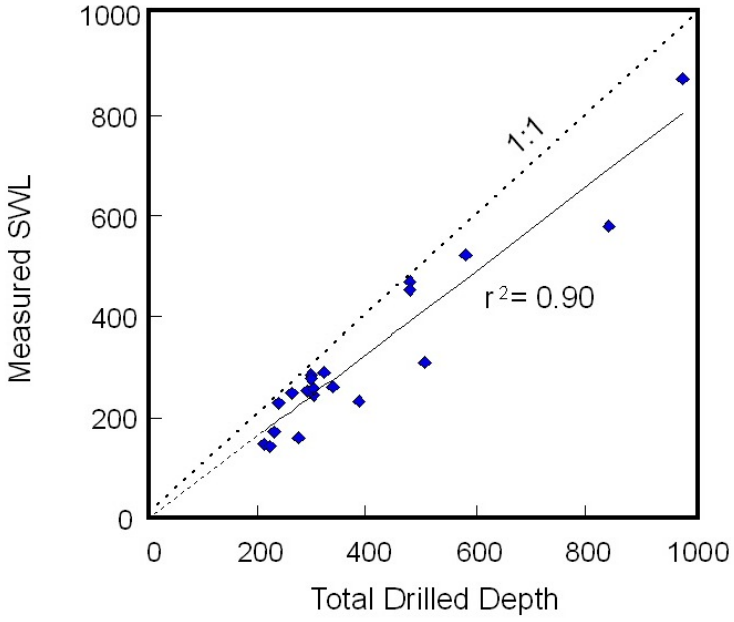

Figure 7. Systematic variation of depth to static water with drilled depth.

CONCLUSIONS AND RECOMMENDATIONS

The aquifer beneath Fraser plateau appears to have limited capacity as a ground-water supply, with 80 percent of wells having yields < 10 gpm and none higher than 20 gpm. In this aquifer, as in many that are hosted in Columbia River basalts, ground water moves along porous zones between massive, less permeable material that restricts the vertical movement of water. Based on the lithologic descriptions seen in drillers' logs and geological observations, chemical weathering may be responsible for reducing the permeability of the basalts beneath the Fraser plateau. The result is that this aquifer is able to supply only small amounts of water and only from zones that have retained sufficient permeability.

Although the low frequency of water-bearing zones reported in wells may reflect hydraulically isolated pockets, the vertical variation of static water levels in active wells indicates that the aquifer is a vertically continuous, interconnected body of ground water rather than a series of discrete perched aquifers interspersed throughout the rock mass. The source of recharge to the aquifer is unknown and should be investigated, although it is likely that recharge derived from precipitation on the plateau is limited (as evidenced by the very few reports of water in the shallowest basalts and the poor vertical interconnection expected across relatively impermeable thicknesses of massive basalt within the geologic section).

The low yields that characterize the producing wells and the high proportion of dry holes indicate that the Columbia River basalts beneath the Fraser plateau do not host a prolific aquifer. Since 80% of water-bearing zones have been encountered at depths shallower than 350 ft, future water supply wells should be developed in the upper 350 feet of this aquifer, rather than deeper in the basalt section.

A number of factors indicate that development of this ground-water resource should be undertaken with caution. In addition to the low yields and high proportion of dry wells that characterize the aquifer, its recharge source(s) and rate of recharge are unknown. Regardless of recharge, however, the aquifer appears to have a very limited capacity to deliver its water to wells. Future development that targets the upper 350 feet of the aquifer should proceed only after a thorough investigation of the recharge source(s), rates of supply, and long-term safe yield of the aquifer, in order to avoid injury to current well owners' diversion rights.

REFERENCES

Boguslawski, N.D., J.W. Fox, L.R. Moyer, K.M. Brackney and K.L. Schmidt, 2003, Remarkable stratigraphic complexity in a Columbia River Basalt aquifer: An example from the Clearwater Canyon, Idaho; Geological Society of America *Abstracts with Programs*, Vol. 35, No. 6, September 2003, p. 550

IDWR, 2008a, Searchable on-line database (well construction information) http://www.idwr.idaho.gov/apps/appswell/searchWC.asp

IDWR, 2008b, On-line downloadable GIS data (permitted wells); http://www.idwr.idaho.gov/gisdata/new%20data%20download/ wells.htm

Lewis, R.S., J.D. Kauffman, R.F. Burmester, J.H. Bush and D.L. Garwood, 2005, Geologic map of the Rudo quadrangle, Clearwater County, Idaho; Idaho Geological Survey Geologic Map GM-37, http://www.idahogeology.org/Products/MapCatalog/default.asp?switch=title&value=GM-37

APPENDIX A

Summary of Well Drillers' Reports Used in this Study

TABLE A.1 - Useable wells in T35N and T36N, R03E

Wells that are (a) inside the study area, (b)independently located by Norma Brand, and (c) deep enough to provide useful information

Contact	URL	Use	TWP	RNG	SEC	Tract	Dry Hole (N.Brand)	GPM	SWL	Water Info	TD	Cas. Dep.	Csg. Dia.	Construction Date	Permit Number	Tag Number	Lithologic Information
BROWN, MARVIN	Related Documents	Domestic	35N	3	11	SWNW	TWO OF THREE			Not found	485	19	6	01/05/1971	743271		Basalt @ 9-76 ft; "green shale, black clay" > 378 ft
BROWN, MARVIN	Related Documents	Domestic	35N	3	11	NESW	TWO OF THREE	12	228	@ 277 in	300	247	6	10/07/1976	743409		Basalt @ 28-156 ft; 201-280 ft
JUDD, CLAUDE	Related Documents	Domestic	35N	3	10	(SESW ?)	DRY			Not found	666	175	6	12/12/1967	743169		Basalt @ 168-230 ft; "scoria, shale" >538
GREEN, JOE	Related Documents	Domestic	35N	3	12	NWNW	DRY			Not found	486	55	6	07/23/1969	743204		Basalt @ 48-94; 153-199; "scoria" 347-463
JUDD, CLAUDE	Related Documents	Domestic	35N	3	10	SESW	DRY			Not found	501	22	8	07/17/1969	743218		Scoria @ 18-108; 161-232; "dark shale" > 455
KINGEN, ROY	Related Documents	Domestic	35N	3	4	NENESE	DRY			Not found	707		8	08/31/1972	743317		Basalt @ 30-165; 185-300; 410-420; > 695
KINGEN, ROY	Related Documents	Domestic	35N	3	4	NENESE	DRY			Not found	475		8	09/08/1972	743318		Basalt @ 60-155; 190-310; 404-413
STUART, DALE H	Related Documents	Domestic	35N	3	1		DRY			Not found	425		6	07/02/1976	743423		Basalt @ 22-114; 146-247
STUART, DALE H	Related Documents	Domestic	35N	3	1	NESW	DRY			Not found	425		6	07/20/1976	743428		Basalt @ 22-114; 146-247
MOORE, JERRY	Related Documents	Domestic	35N	3	13	SESE	DRY			Not found	251			06/18/1981	743552		Basalt @ 16-146; TD=251
STEWART, JOYCE	Related Documents	Domestic	35N	3	3	NENE	DRY	0		Not found	545	75		08/29/1996	743917		Lava @ 75-230; 450-480
STICKNEE, DAN, S	Related Documents	Domestic	35N	3	17	SWSWNE	DRY	0		Not found	708	199	8	08/15/1999	744045	D0010396	Basalt (decomposed to hard) @ 54-477; "argillite" > 665
WILSON, KENNETH	Related Documents	Domestic	35N	3	17	SENW	DRY			Not found	520	21	8	09/14/1999	744049	D0010412	Lava @ 115-185; "decomposed granite" > 445
CARR, DALE	Related Documents	Domestic	36N	3	32	SESW	DRY			Not found	552		6	07/14/1983	743570		Basalt @ 6-117; 278-514
CARR, DALE	Related Documents	Domestic	36N	3	32	SESW	DRY			Not found	537		6	07/21/1983	743571		Lava @ 31-115; 163-509
CARR, DALE	Related Documents	Domestic	36N	3	32	SESW	DRY			Not found	567	200	6	08/09/1983	743572		Lava @ 48-121; 161-530
JOHNSON, SHAWN	Related Documents	Domestic	35N	3	11	NWNW	???	5	480	@ 522 in	580	580	8	08/22/2007	848386	D0053753	Basalt @ 48-112; "black shale, basalt" > 485
JOHNSON, SHAWN	Related Documents	Domestic	35N	3	11	NWNW	???	0	0	Not found	360	18	8	08/14/2007	848471	D0053754	Basalt @ 45-115; TD=360
JUDD, CLAUDE	Related Documents	Domestic	35N	3	10	SESW		15	209	@ 172 in	234	234	6	10/24/1970	743227		Basalt @ 46-73; >118
GREEN, JOE	Related Documents	Domestic	35N	3	12	NWNW		20	198	@ 108 in	305	210	6	11/19/1970	743228		Basalt (decomposed) @ 17-63; 119-178; 210-242
STEWART, WESLE	Related Documents	Domestic	35N	3	10	NWSW			315	@ 312 in	505	505	6	01/16/1971	743270		Basalt @ 5-64; 110-158; basalt +"black sand" > 365
STUART, DALE H	Related Documents	Domestic	35N	3	1	NESW		10	260	@ 290 in	325	260	6	08/19/1976	743424		Basalt @ 18-174; >230
WINTERS, EUGENE	Related Documents	Domestic	35N	3	5	SENE		6	220	@ 228 in	242	19	6	05/14/1978	743479		Lava @ 17-57; > 113
GANGWER, BOB	Related Documents	Domestic	35N	3	16	SENW		3	208	@ 74 in "	264	23	6	11/05/1979	743510		Lava 18-79; > 114
BORDER, TED	Related Documents	Domestic	35N	3	10	NWNE		2	148	@ 148 in	213	28	6	09/19/1980	743540		Basalt @ 28-106; 146-212
ROBNETT, DAVE	Related Documents	Domestic	35N	3	8	NESW		4	110	@ 68 in be	226	113	6	05/13/1980	743545		Lava @ 63-83; 106-194
MC KINNON, DAN	Related Documents	Domestic	35N	3	15	SWNW		5	156	@ 288 in	298	138	6	11/18/1987	743609		Basalt @ 55-78; 130-295
MORRE, JERRY	Related Documents	Domestic	35N	3	13	SWNE		0.25	130	@ 90 in be	277			09/22/1988	743645		Basalt @ 90-167
BIRD, WILLIAM E	Related Documents	Domestic	35N	3	5	SESE		5	350	@ 470 in	480	62	8	11/30/1993	743753		Basalt @ 58-130; 190-420
WALKER, GEORGE	Related Documents	Domestic	35N	3	5	SENWNE		3	260	@ 245 in	303	18	8	08/21/1995	743840		Basalt @ 8-120; 155-200; 245-298
SNYDER, MICHAEL	Related Documents	Domestic	35N	3	17	SENW		5	325	@ 235 in	385	18	8	08/06/1996	743892		Basalt @ 15-70; > 110
SNYDER, JOHN	Related Documents	Domestic	35N	3	8	NWNW		5	501	@ 580 in	845	137	8	06/25/1999	744035	D0010160	Basalt @ 2-165; > 375 ("shale" interbedded)
STICKNEE, DAN	Related Documents	35N		3	17	SWSWNE		3	750	@ 870 in "	980	642	6	09/26/2000	766666	D0013775	Deepened; log starts in "black granite"
LUTES, KEITH	Related Documents	Domestic	35N	3	4	SWSE		2	435	@ 452 in	480	478	8	10/04/2002	787361	D0022691	Basalt @ 65-160; 190-395; . . 452
JACKSON, BILL	Related Documents	Domestic	35N	3	9	NESW				Not found	321		6	10/29/1979	743512		Basalt @ 17-97; 136-192
JACKSON, BILL	Related Documents	Domestic	35N	3	9	SWSW				Not found	53		6	10/29/1979	743513		Basalt 14-43; TD=53
JACKSON, BILL	Related Documents	Domestic	35N	3	9	NESW				Not found	456	148	6	12/12/1979	743514		Basalt @ 6-91; 141-218
JACKSON, BILL	Related Documents	Domestic	35N	3	9	NESW		20	246	@ 255 in	293	18	8	12/23/1979	743515		Basalt @ 6-105; >137
JACKSON, BILL	Related Documents	Domestic	35N	3	9	SWSW				Not found	321		6	11/08/1979	743516		Basalt @ 7-118
JACKSON, PAUL	Related Documents	Domestic	35N	3	17	SENE				Not found	427		6	11/19/1979	743517		Basalt @ 12-312
JACKSON, PAUL	Related Documents	Domestic	35N	3	17	SENE		3	220	@ 262 in	338	28	6	11/29/1979	743518		Lava @ 6-84; > 126

Wells that are (a) outside the study area, (b) not located by Norma Brand, and (c) not deep enough to provide usefulsubsurface information

SIMLER, DON	Related Documents	Domestic	35N	3	33	SESE		3	6		162	60	6	01/27/1970	743220		"Granite" lithology (out of study area)
MALLOY, VIOLA	Related Documents	Domestic	35N	3	13	NESE		7	105		230	14	8	05/29/1965	743156		Lithologic log too poor to be useful (1965 date)
HANCOCK, LEO A	Related Documents	Stockwate	35N	3	24	NENE		50	70		200	20	6	02/16/1977	743436		Normal basalt lithology
EASTMAN, GENE	Related Documents	Domestic	35N	3	24	NENE		6	65		207	58	6	11/09/1979	743521		Normal basalt lithology
MOORE, ROSCOE	Related Documents	Domestic	35N	3	11	SESE		12	120		190	19	6	10/17/1979	743529		Normal basalt lithology
TAYLOR, BYRAN	Related Documents	Domestic	35N	3	8	SENE	DRY		SWL=0 ft &	Yi	354			09/11/1980	743548		
AULTZ, LANIS N	Related Documents	Domestic	35N	3	24	SWNE		30	20		75	58	6	08/05/1993	743733		Basalt, but TD only 75 ft, so not useful
MC INTIRE FARMS	Related Documents	Domestic	35N	3	32	SWSE		1.5	200		602	19	8	07/22/1996	743906		
CAMPBELL, WILLIE	Related Documents	Domestic	35N	3	7	NWNW		5	44		145	18	8	09/01/2006	841944	D0046059	Basalt, no interbed info. TD only 145 ft
PUCKETT, ANDREW	Related Documents	Domestic	35N	3	32	NWNW		1	86		250	250	6	09/27/2007	849248	D0054033	"Granite" lithology (out of study area)
PUCKETT, ANDREW	Related Documents	Domestic	35N	3	32	NWNW		1	75		200	200	6	10/01/2007	849868	D0054034	"Granite" lithology (out of study area)

APPENDIX B

Comparison of Reported and Actual Well Locations

Table B.1 - Comparison of locations reported in IDWR well location shapefile (IDWR, 2008b) with locations supplied by Mrs. Norma Meyer Brand, 4294 Lower Fords Cr. Rd., Orofino, ID 83544-9660 (208-435-4354)

Entries highlighted by indicate mislocated wells

		As located in IDWR's well shapefile				As located by Mrs. Norma Brand			
Owner	**Permit Number**	**Twp**	**Rge**	**Sec**	**QQQ**	**Twp**	**Rge**	**Sec**	**QQQ**
Michael Snyder	743892	35N	3E	17	SE NW				
Joe Greene	743228	35N	3E	12	NW NW				
Joe Greene	743204	35N	3E	10	NW NW			12	
Jerry Moore	743552	35N	3E	24	SE SE			13	
Jerry Moore	743644 / 45	35N	3E	24	SW NE			13	
Claude Judd	743227	35N	3E	10	SESW				
Claude Judd	743218	35N	3E	16	SE NW			10	SE SW
George Walker	743840	35N	3E	5	SE NW NE				
Dan Stickney	744045	35N	3E	17	SW SW NE				
Dan Stickney	766666	35N	3E	17	SW SW NE				SW SW SW
Dale Stuart	743423	35N	3E	35	-			1	
Dale Stuart	743424	35N	3E	35	NE SW			1	
Dan McKinnon	743609	35N	3E	15	SW NW				
Byran Taylor	743548	35N	3E	8	SE NE				
Joyce Stewart	743917	35N	3E	3	NE NE				
Roy Kingen	743317	35N	3E	4	SE				NE NE SE
Roy Kingen	743318	35N	3E	4	SE				NE NE SE
Keith Lutes	787361	35N	3E	4	SW SE				
Eugene Winter	743479	35N	3E	5	SE NE				
Ted Borders	743540	35N	3E	9	NE NE			10	NW NE
William Bird	743753	35N	3E	5	NW SE				SE SE
Marvin Brown	743271	35N	3E	11	SW NW				
Kenneth Wilson	743049	35N	3E	18	NE NE			17	SE NW
Bob Gangwer	743510	35N	3E	16	SE NW				
John Snyder	744035	35N	3E	6	NW NW			8	
Dale Carr	743570 / 71 / 72	36N	3E	32	SE SW				
Paul Jackson	743517 / 18	36N	3E	17	SE NE	35N	3		
Bill Jackson	743513 / 16	36N	3E	9	SW SW	35N	3		
Bill Jackson	743512 / 14 / 15	36N	3E	9	NE SW	35N	3		
Bob Gangwer	743863	36N	3E	31	SE SE				