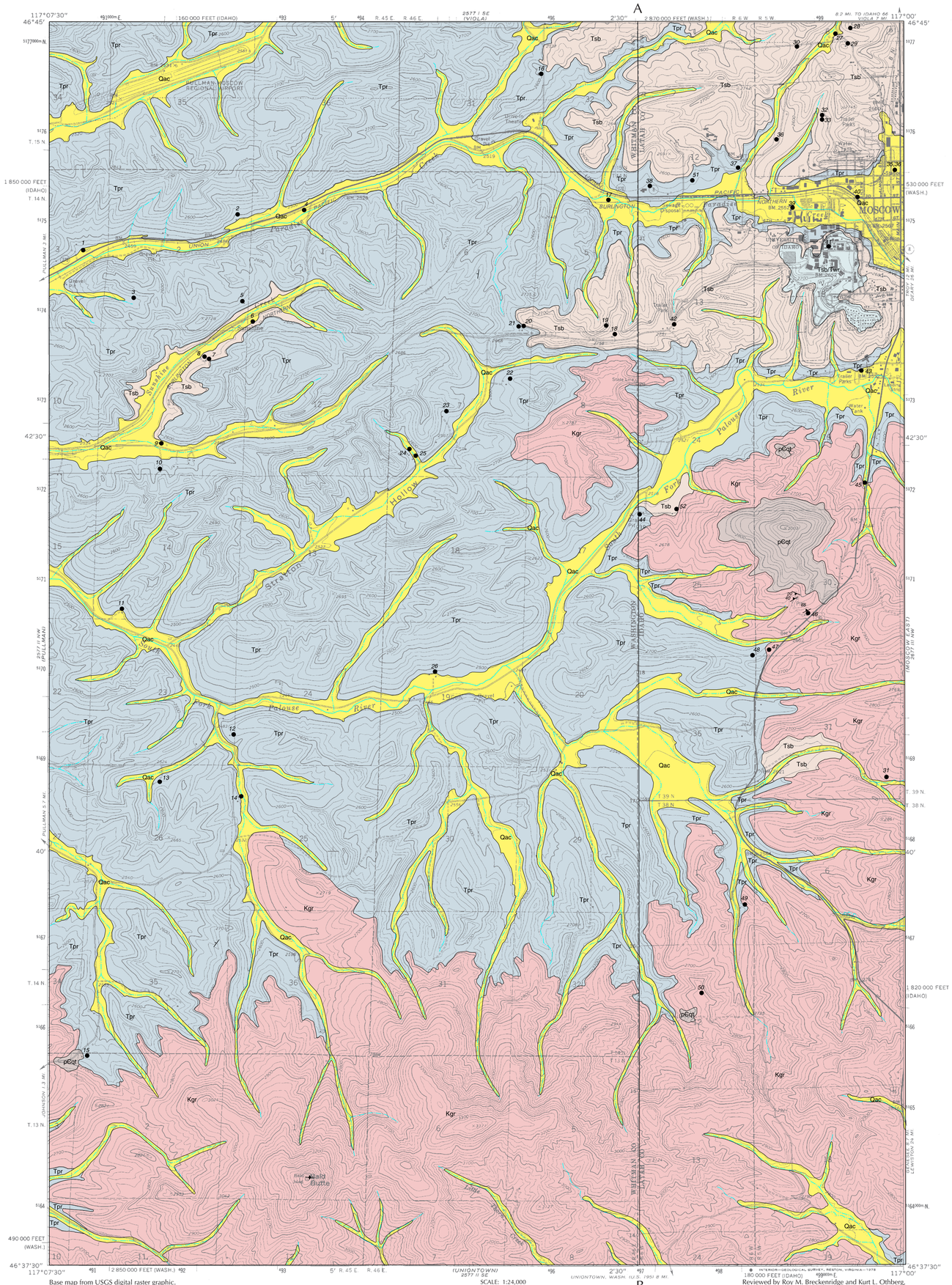
Bedrock Geologic Map of the Moscow West Quadrangle, Latah County, Idaho, and Whitman County, Washington

John H. Bush, Andrew P. Provant, and Steve W. Gill

1998

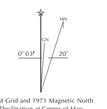


Base map from USGS digital raster graphic.
Hydrography from Idaho Department of Lands digital line graph.

Control by USGS and NOAA/NOAA.

Topography by photogrammetric methods from aerial photographs taken 1957. Field checked 1964.

Polyconic projection. 1927 North American Datum. 10,000-foot grids based on Washington coordinate system, south zone, and Idaho coordinate system, west zone. 1000-meter Universal Transverse Mercator grid ticks, zone 11.
National Geodetic Vertical Datum of 1929



UTM Grid and 1971 Magnetic North Declination at Center of Map

SCALE: 1:24,000

1 1/2 0 1 MILE

1 0.5 0 1 KILOMETER

Contour Interval 20 Feet

QUADRANGLE LOCATION

Reviewed by Roy M. Breckenridge and Kurt L. Othberg, Idaho Geological Survey.

Digital cartography by Jane S. Freed at the Idaho Geological Survey's Digital Mapping and Information Lab.

Idaho Geological Survey Digital Mapping and GIS

INTRODUCTION

The geologic map of the Moscow West quadrangle represents a compilation of previous research, water well data (Table 1), and additional field work. The loess distribution of the Palouse Formation was not illustrated in keeping with the emphasis on bedrock geology. The varying thickness of loess forms the rolling Palouse topography and buries the nearly flat upper surface of basalt in the eastern margin of the Columbia Plateau. As a result, the Priest Rapids Member of the Wanapum Basalt (Tpr) appears thicker and the upper surface is flatter than shown on the map. Outcrops are rare, and all contact lines are interpretative.

Regional maps by Rember and Bennett (1979) and Swanson and others (1977, 1979a, 1980) as well as larger scale maps by Tullis (1940, 1944) were used in the compilation. Considerable reliance was placed on a 1:62,000-scale map by Hooper and Webster (1982). Outcrops located and identified by Hooper and Webster were used to assist in extrapolating contact lines. Numerous reports on the Moscow area were consulted in interpreting the subsurface. Provant (1995) cites most of these research works. The basalt chemistry was analyzed by the GeoAnalytical Laboratory at Washington State University. Paleomagnetism was determined at the Idaho Geological Survey.

DESCRIPTION OF MAP UNITS

Prebasalt rocks here and on surrounding quadrangles have been previously mapped as several different units, including Precambrian pre-Belt Supergroup, Belt Supergroup, metamorphosed Belt Supergroup, Cambrian quartzite, and Cretaceous metamorphosed and unmetamorphosed Idaho batholith (Tullis, 1940, 1944; Bond, 1978; Swanson and others, 1980; Rember and Bennett, 1979; Hooper and Webster, 1982; and Anderson, 1991). For this map, the prebasalt rocks were divided into a Precambrian quartzite unit and a Cretaceous undifferentiated Idaho batholith unit.

The stratigraphic nomenclature for the Columbia River Basalt Group is based on that presented by Swanson and others (1979b). The group is divided into four formations: from base upward, these are the Imnaha, Grande Ronde, Wanapum, and Saddle Mountains. No basalt of the Imnaha and Grande Ronde Formations is exposed in the Moscow West quadrangle. However, the Grande Ronde is found in numerous deep wells in the Moscow area.

Latah Formation sediments occur as units above the Columbia River basalt flows at the surface and as interbeds between flows in the subsurface. At the surface, the Latah Formation consists of a sequence of unconsolidated sediments that overlie most of the basalt units. Earlier researchers on the Moscow area referred to these sediments as the Canfield-Rogers deposit (Hubbard, 1956; Hosterman and others, 1960). There are similar deposits throughout Latah County. Informally, this unit is named herein as the sediments of Bovill for exposures in clay pits near Bovill in eastern Latah County. The term is to be used for Miocene sediments that are laterally equivalent with and overlie the uppermost laterally extensive basalt flow. In places, the sediments lie directly on prebasalt rocks.

In the subsurface, the Latah Formation consists of several interbeds separating Columbia River basalt flows. The interbed beneath the Priest Rapids Member, but above the uppermost Grande Ronde Basalt in the Moscow area, correlates to the Vantage Member of the Ellensburg Formation of central Washington. Siems and others (1974) correlated this unit from the western edges of the Columbia River Plateau to Pullman, Washington. Brown (1976) correlated this unit in the subsurface from Pullman into the Moscow basin. The sedimentary units beneath the Vantage and above the prebasalt rocks in the Moscow basin are informally herein referred to as the sediments of Moscow.

SURFICIAL DEPOSITS

Qac — **Alluvium and colluvium (Holocene)**—Stream, slope-wash, and debris-flow deposits. Composition varied: commonly reworked loess or mixtures of loess, basalt, and granitoid fragments. Most areas are stream deposits that grade laterally into loess of the Palouse Formation and contain slope-wash deposits derived from the loess-covered hills.

LATAH FORMATION

Tsb — **Sediments of Bovill (Miocene)**—Clay, silt, sand, and gravel deposit that is laterally equivalent with and generally overlies the Priest Rapids Member of the Columbia River Basalt Group. In places, it overlies Precambrian and Cretaceous prebasalt rocks. The clays are white, yellow, red, and brown, kaolinite-rich, and up to 40 feet thick. Exposures are rare; thus, information is obtained from well logs and excavations.

The sediments of Bovill are dominated by clays with minor lenses of silt, sand, and gravel. Over 20 feet of sediment was temporarily exposed near the west end of A street (SW 1/4, sec. 7). At that locality, a 7-foot unit of poorly sorted, conglomeratic, micaceous cross-bedded sand is in contact with a vesicular Priest Rapids flow top. Rare subangular conglomeratic clasts up to 4 inches in diameter include quartz, granite, and vesicular basalt. The sand grades upward into alternating layers of silt and clay.

Excavations of similar deposits were also examined above basalt along Sweet Avenue at the southeast end of the University of Idaho. At that locality, irregular lenses and layers of poorly sorted micaceous sand occur in clay and silt. Plant fossils and pollen were identified as Miocene (W.C. Rember, oral commun., 1995). In general, nonbedrock hills in west Moscow are composed of loess deposits with a core of sediments of Bovill. Coarser units are more erodible and have been found in excavations and wells close to existing stream drainages.

Depositional information for the sediments of Bovill is obtained from regional studies. Origins of the sediments include fluvial, lacustrine, bog, and deltaic environments. However, most of the sediments in Moscow are believed to have formed as fluvial deposits. Deposition was primarily caused by Priest Rapids flows creating a raised base level, which in turn caused deposition of kaolinitic clay, quartz sand, and minor gravel from streams eroding nearby exposures of weathered prebasalt rock.

Tv — **Vantage Member (Miocene)**—Consists of sediments between the lowermost Priest Rapids and uppermost Grande Ronde basalts in the Moscow-Pullman area (Siems and others, 1974; Brown, 1976; Kopp, 1994). The unit exceeds 300 feet in thickness beneath Moscow but thins westward to less than 20 feet at Pullman (Lin, 1967). The Vantage is not exposed in Moscow. All data are from water well logs. The sediments consist of interlayered sand, silt, and clay. Wood fragments are commonly found. The sand units are poorly sorted with a high clay content, and the coarse grains of quartz and feldspar are angular with only slightly rounded edges (Cavin, 1964). Seen in cross section.

Tsm — **Sediments of Moscow (Miocene)**—Interbeds of sand, silt, and clay between Grande Ronde flows and between the lowermost flow and prebasalt rocks. Several discontinuous interbeds are in the subsurface beneath Moscow. However, two major units over 100 feet thick can be correlated between wells (Cavin, 1964; Lin, 1967). Eastward, the sand content increases as does the grain size. Westward, these interbeds pinch out or thin to less than a few feet in thickness (Brown, 1976). Seen in cross section.

COLUMBIA RIVER BASALT GROUP

Saddle Mountains Formation

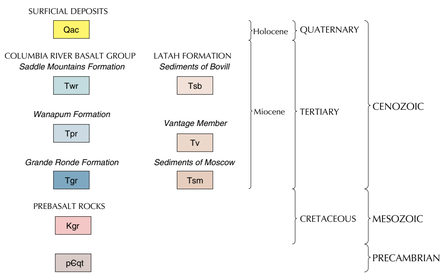
Twr / Tsb/Twr — **Weissenfels Ridge Member (Miocene)**—Medium- to coarse-grained basalt with microphenocrysts of plagioclase and olivine in an intergranular groundmass with minor glass (Hooper and others, 1985). In the Pullman area, outcrops of this member belong to the basalt of Lewiston Orchards (Hooper and Webster, 1982). Distribution in the northern area of the quadrangle was extrapolated from outcrops on the Viola quadrangle. Distribution beneath the sediments of Bovill (Twr/Tbs) in southwest Moscow (sec. 18) was extrapolated from well data and a foundation exposure for McClure Hall on the University of Idaho campus where 15 feet of basalt occurs above clay, silt, and sand with organic debris. Chemical analyses indicate the flow is the basalt of Lewiston Orchards. Major elements as follows: SiO_2: 50.19; Al_2O_3: 14.80; TiO_2: 6.60; FeO: 11.47; MnO: 0.19; CaO: 11.00; MgO: 6.18; K_2O: 0.36; Na_2O: 2.60; P_2O_5: 0.59.

Laboratory analysis of core from the foundation exposure indicates a normal polarity at the site. Swanson and others (1977, 1979a) report a normal polarity for the Lewiston Orchards flow. The distribution is probably greater than shown, but the general lack of outcrops and insufficient chemical analyses prevented accurate delineation. Interpreted as intracanyon flows that occupied channels in the Priest Rapids Member and in sediments of Bovill without great lateral extent in the Moscow area.

Wanapum Formation

Tpr — **Priest Rapids Member (Miocene)**—Consists of two to three flows or flow units of medium- to coarse-grained basalt with microphenocrysts of plagioclase and olivine in a groundmass of intergranular pyroxene, ilmenite blades, and minor devitrified glass. Total thickness of about 250 feet. Several workers have previously identified and described these flows (Bingham and Grolier, 1966; Wright and others, 1973; Swanson and others, 1977, 1979a). The flows have reversed magnetic polarity (Wright and others, 1973; Swanson and others, 1979a, b).

CORRELATION OF MAP UNITS



The member is exposed in numerous quarries throughout the quadrangle, but exposures of contacts between individual flow units and flows are rare. Hooper and Webster (1982) report three chemical types in the area, and their map shows the locations of most Priest Rapids outcrops. One exposure (NE 1/4, sec. 31, T. 15 N., R. 46 E.) was analyzed for major elements. At that locality, the base of a flow or flow unit occurs over another Priest Rapids flow top. The chemical analysis of the uppermost flow indicates a second Priest Rapids flow or flow unit. Major elements as follows: SiO_2: 51.18; Al_2O_3: 13.67; TiO_2: 3.26; FeO: 13.10; MnO: 0.25; CaO: 9.30; MgO: 4.84; K_2O: 1.01; Na_2O: 2.63; P_2O_5: 0.78.

Tgr — **Grande Ronde Formation (Miocene)**—Consists of fine-grained to very fine-grained aphyric flows of Grande Ronde chemical type (Wright and others, 1973; Swanson and others, 1977, 1979a; Reidel and others, 1989). No exposures occur in the mapped area, but the formation is found in several deep wells (Lum II and others, 1990). In the Moscow area, Grande Ronde flows occur between the elevations of 2,070 feet and 1,371 feet (Provant, 1995), where they are interbedded with sediments of Moscow.

PREBASALT ROCKS

Kgr — **Undifferentiated intrusive rocks (Cretaceous)**—Compositions include quartz tonalite, hornblende monzodiorite, and hornblende granodiorite. Foliation is common in places. Mineral sizes range from medium-grained equigranular to coarse-grained equigranular. The monzodiorite contains plagioclase (An_{32}) with slight normal zoning, microcline, and hornblende (Hooper and Webster, 1982). The tonalities are composed of quartz, unzoned andesine (An_{38}), muscovite, and biotite (Hoffman, 1932). Pegmatite veins are locally present but more common in the tonalites. Hooper and Webster (1982) report a date of 69.8 +/- 2.6 m.y. for similar rocks on the adjoining Pullman quadrangle. Granitoid rocks in sec. 8, T. 14 N., R. 46 E., based on data from Carmichael (1956) and Walters and Clancy (1969).

pCqt — **Quartzite (Precambrian)**—Crops out on several ridge tops in the southern part of the quadrangle. Consists primarily of recrystallized quartz with muscovite, biotite, and zircon accessories. Similar quartzites to the east on Paradise Ridge of the adjoining Moscow East quadrangle have been mapped as Prichard Formation of the Belt Supergroup (Tullis, 1944), pre-Belt prebasalt rocks (Bond, 1978), and Revett Formation of the Belt Supergroup (Anderson, 1991). Hooper and Webster (1982) suggest a Cambrian age for these quartzites based on the lack of laminations, which are common in Belt Supergroup rocks, and on their similarity to Cambrian quartzites in northeast Washington. Bush and Priebe (1995) suggest that similar quartzites are erosional remnants from a Precambrian unit of quartzite, gneiss, and schist rather than a unit dominated by quartzite.

SYMBOLS

- Contact: approximately located
- 71 — Attitude of major foliation trends
- Vertical or near-vertical foliation trend
- 88 — Attitude of basalt flows
- 1 — Location of wells reported in Table 1

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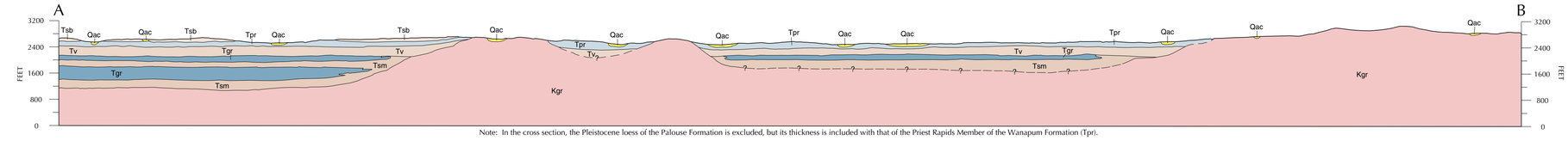
Table 1. Wells on the Moscow West Quadrangle

Number on Map	Owner	Year Drilled	Well Depth (ft)	Land Surface Elev. (ft)	Reported Depth to Water (ft)	Well Type[1]	Depth to Bedrock (ft)	Uppermost Rock Unit	Remarks
1	WWP	1957	259	2470	152	D	8	Tpr	Driller's log
2	Kopf, Keith	1979	270	2490	130	D	--	--	Data from owner
3	Kopf, Ray	1993	330	2560	300+	D	--	--	Data from owner
4	Pullman test well #11	1976	982	2470	200	T	12	Tpr	Driller's log
5	Felsted, Harold	1974	394	2630	354	D	69	Tpr	Driller's log
6	Paulson, Bill	1991	405	2590	257	D	49	Tpr	Driller's log
7	Helm, Boone	--	126	2570	--	D	--	--	Data from owner
8	Helm, Boone	--	350	2585	--	--	--	--	Data from owner
9	Pinzino, Dean	--	400+	2570	--	D, S	--	--	Data from owner
10	Ostrom, Dave	--	120	2600	--	D	--	--	Data from owner
11	Druffel, Craig	1990	208	2470	80	D	2	Tpr	Driller's log
12	Meyer, Raymond	1965	80	2515	50	D	45	Tpr	Driller's log
13	Jennings, R.	--	260	2540	--	D	--	--	Data from owner
14	Lyon, Robert	--	55	2520	--	D	--	--	Walters (1969)
15	Scarnecchia, D.	--	125	2660	--	D	--	--	Data from owner
16	Hagedorn, Gerry	1918	100	2610	--	D	--	--	Walters (1969)
17	Palouse Prod. Inc.	1977	338	2600	182	I	14	Tpr	Driller's log
18	Wickard, Bruce	--	155	2720	--	D	--	--	Data from owner
19	Williams, Guy	1987	380	2660	186	D	104	Tpr	Driller's log
20	Anderson, Edgar	--	350	2650	--	Unused	50	Tpr	Walters (1969)
21	Anderson, Edgar	1940	212	2650	--	D	90	Tpr	Walters (1969)
22	Boone, Mike	--	175	2645	--	D	--	--	Data from owner
23	Kent, Darrell	--	Spring	2580	--	D, S	--	--	Data from owner
24	Braden, J.	--	100	2570	--	--	--	Tpr	Lum II (1990)
25	Braden, J.	--	353	2570	--	--	--	Tpr	Lum II (1990)
26	Brown, L.	--	180	2485	--	D	--	Tpr	Lum II (1990)
27	Harden, R.E.	--	150	2630	--	D	--	--	Crosthwaite (1975)
28	Harden, Kurt	1988	65	2620	35	D	59 ?	--	Driller's log
29	Harden, Dick (R.E.)	1966	376	2682	--	D	190	Tpr	Crosthwaite (1975)
30	Adams, Kevin	1994	208	2665	150	D	190	Tpr	Driller's log
31	Brandt, Steve	1994	279	2630	128	D	45/115	Tsb/Tpr	Driller's log/owner
32	City of Moscow #7	1962	667	2614	--	M, O	34/163	Tsb/Tpr	Crosthwaite (1975)
33	City of Moscow #8	1964	1458	2617	--	M	22/108	Tsb/Tpr	Crosthwaite (1975)
34	City of Moscow #2	1925	320	2568	20	M	36	Tpr	Crosthwaite (1975)
35	City of Moscow #3	1928	262	2569	20	M	32	Tpr	Crosthwaite (1975)
36	University of Idaho #3	1962	1336	2558	256	M	18	Tpr	Driller's log
37	University of Idaho #4	--	747	2554	--	M	--	--	Baines (1992)
38	Appaloosa Horse Club	1983	214	2540	70	D	29	Tpr	Driller's log
39	University of Idaho #2	1951	354	2557	90	M	17/29	Tsb/Tpr	Crosthwaite (1975)
40	Olsen, Louis (BWC)	1972	238	2560	76	D	12/48	Tsb/Tpr	Driller's log
41	University of Idaho #1	1920	330	2601	--	M	36/98	Tsb/Tpr	Crosthwaite (1975)
42	Hattrup, H.	1947	141	2745	--	D	--	--	Crosthwaite (1975)
43	Terrace Gardens	1984	70	2562	--	U	--	--	Driller's log
44	Lyon, Glen	1992	155	2580	84	D	--	Tpr	Driller's log
45	Deesten, Martin	1945	--	2640	--	D	--	--	Crosthwaite (1975)
46	Lucas, James	1950	170	2770	--	D	--	--	Driller's log
47	Andrews, Duane	1994	176	2650	--	D	--	--	Data from owner
48	Barber, David	1985	175	2630	--	D	--	Tpr	Driller's log/owner
49	Redinger	--	--	2610	--	D	--	--	Data from owner
50	Bindl, John	1992	230	2830	27	D	52	Kgr	Driller's log
51	City of Moscow #9	1982	1253	2538	280	M	20	Tpr	Driller's log
52	Jennings, Ralph	1970	276	2538	40	D	82	Kgr	Driller's log

[1] D = domestic well; T = test well; S = spring; I = irrigation well; O = observation well; M = municipal well



Note: In the cross section, the Pleistocene loess of the Palouse Formation is excluded, but its thickness is included with that of the Priest Rapids Member of the Wanapum Formation (Tpr).

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