



# Ralston Hydrologic Services, Inc.

## GROUND WATER CONSULTING AND EDUCATION

1122 East B Street, Moscow, ID USA 83843  
Voice and FAX 208-883-0533, E-mail [ralston@moscow.com](mailto:ralston@moscow.com)

### MEMORANDUM

To: Helen Harrington, Idaho Department of Water Resources  
From: Dale Ralston, RHS  
Subject: Completion of Moscow Test Well Project  
Date: February 21, 2007

The purpose of this memo is to provide a summary of well completion and geologic information from the construction of four test wells near the City of Moscow, Idaho. The memo includes three parts: 1) project description, 2) well completion information and 3) geology as interpreted by Dr. John Bush.

#### PROJECT DESCRIPTION

The objective of the Moscow Deep Test Well project was to construct test wells completed at four different depths at a drill site location northwest of the City of Moscow. The target stratigraphic intervals that were used to guide the drilling project, formulated by researchers from the University of Idaho and Washington State University, are listed below. The target depths and elevations were developed based on lithologic information from nearby university and city wells.

- **Shallow sediments of Bovill** – Target zone is the bottom 5 to 10 feet of sediments directly on top of the Wanapum basalt. This well will be completed only if sufficient saturated sands exist. The 5 to 10 feet of well screen should be placed in the bottom of the hole directly on the top of the Wanapum Basalt.
- **Wanapum Basalt** – Target zone is between elevations of 2390 and 2370 feet above mean sea level. Bottom of the screen should be placed about 10 feet above the base of the basalt. The screen should be placed between the target elevations of 2390 and 2370 feet unless a “major” producing zone is encountered at a higher or lower elevation (but not less than 10 feet above the base of the Wanapum Basalt). (*Screen interval depth of about 210 to 230 feet*)
- **Vantage Member** – Target zone is between the elevations of 2260 and 2200 feet above mean sea level. The target zone is a potential coarse sand layer about 80 feet below the bottom of the Wanapum Basalt. Depending on the actual thickness of the sand layer, 5 to 10 feet of well screen should be used. (*Screen interval depth of about 340 to 400 feet*)

- **Upper Grande Ronde Basalt** – Target zone is between the elevations of 1830 and 1810 feet above mean sea level. One producing zone is Moscow 9 is about 90 feet below the top of the Grande Ronde. This producing zone is the potential target unless a “major” producing zone is encountered at a shallower or deeper depth. Ideally, this well should not extend deeper than an elevation of 1750 feet above mean sea level. (*Screen interval depth of about 770 to 790 feet*)

Drilling specifications were developed based on the lithologic targets and bid documents were prepared. The University of Idaho was responsible for financial administration of the project. Project funding was from the Idaho Department of Water Resources. H2O Well Services from Coeur d’Alene was low bidder and was awarded the contract. The plan was to drill the Upper Grande Ronde Basalt well first so the lithology would be known for the remaining three wells.

A drilling site that had been selected by researchers from the UI and WSU is located on UI land near the Washington-Idaho state line (Figure 1). An unimproved farm road provides access to the site. The originally selected drill site was not available in March 2006 when the driller was ready to mobilize on site because of wet field conditions. The decision was made to move the well construction to a site located about 0.5 miles east of the initially selected site. The drill rig was moved to the East Drilling Site in early June 2006.

The sediment and basalt sequence encountered in the first 70 feet at the East Drilling Site was more like Moscow well #8 than the three wells upon which the drilling plan was developed (Moscow well #9, UI wells #3 and #4). The decision was made to complete a shallow well at the East Drilling Site and then mobilize the drilling equipment to the original drilling site, hereafter termed the West Drilling Site (Figure 1). Approval of the change in drilling location was sought and obtained from the University of Idaho. The remaining three wells were constructed at the West Drilling Site.

Drilling activities proceeded with construction of Wanapum Well, the Vantage Well and the Upper Grande Ronde Well. The greatest drilling difficulties were encountered in the Upper Grande Ronde Well when a welded joint failed down hole when casing was being pulled back. All problems were ultimately solved and the last well was completed in September 2006.

## WELL COMPLETION INFORMATION

Well completion information is provided in this section along with the geologic information provided by the driller. The stratigraphic interpretation of the material penetrated during construction of the four wells prepared by Dr. John Bush is presented in the following section.

### **Sediments of Bovill Well**

This well was constructed at the East Drilling Site to a total depth of 73 feet using an air rotary drilling rig. Twelve-inch diameter steel casing was driven to a depth of 73 feet and then removed as the permanent casing was installed. The well has 4-inch diameter PVC casing to a depth of 70 feet with 0.010-inch, factory slotted casing in the depth interval of 60 to 70 feet. A sand pack was installed around the casing in the depth

interval of 57 to 70 feet with a bentonite seal from land surface to a depth of 57 feet. Eight-inch diameter surface casing was installed to a depth of about 10 feet and equipped with a locking cap. The reported yield by the driller was 5 to 8 gpm (gallons per minute). The reported depth to water was 35 feet below ground surface. The geologic log prepared by the well driller is provided below.

|               |                                     |
|---------------|-------------------------------------|
| 0 to 3 feet   | fill, coarse rock                   |
| 3 to 13 feet  | dark brown soil                     |
| 13 to 19 feet | tan/brown soil, clay-like           |
| 19 to 23 feet | yellow and tan clay-like with sands |
| 23 to 34 feet | broken basalt, medium               |
| 34 to 45 feet | blue/tan clay                       |
| 45 to 55 feet | white and tan clay with sand        |
| 55 to 70 feet | sand with clay and water            |
| 70 to 73 feet | yellow/tan clay                     |

### **Wanapum Basalt Well**

This well was constructed at the West Drilling Site to a total depth of 282 feet using an air rotary rig. Eight-inch diameter temporary steel casing was driven to a depth of 63 feet and then removed as the permanent casing was installed. The well has 4-inch diameter PVC casing to a depth of 280 feet with 0.010-inch, factory slotted casing in the depth interval of 270 to 280 feet. A sand pack was installed around the casing in the depth interval of 265 to 280 feet with a bentonite seal from land surface to a depth of 265 feet. Eight-inch diameter surface casing was installed to a depth of about 10 feet and equipped with a locking cap. The reported yield by the driller was 50 gpm. The reported depth to water was 170 feet below ground surface. The geologic log prepared by the well driller is provided below.

|                 |                               |
|-----------------|-------------------------------|
| 0 to 3 feet     | gravel fill                   |
| 3 to 18 feet    | brown clayish soil            |
| 18 to 43 feet   | yellow clayish soil           |
| 43 to 58 feet   | soft brown basalt with rounds |
| 58 to 110 feet  | hard basalt                   |
| 110 to 116 feet | basalt with water, 5 gpm      |
| 116 to 245 feet | hard basalt                   |
| 245 to 248 feet | basalt with rounds            |
| 248 to 277 feet | hard basalt                   |
| 277 to 282 feet | sand and clay, water          |

### **Vantage Member Well**

This well was constructed at the West Drilling Site to a total depth of 355 feet using an air rotary rig. Twelve-inch diameter temporary steel casing was installed and driven to a depth of 60 feet. A 12-inch diameter open hole was drilled through the basalt and then 8-inch diameter temporary steel casing was advanced to a depth of 345 feet. Both sections of temporary casing were removed as the permanent casing was installed. The well has 4-inch diameter PVC casing to a depth of 350 feet with 0.010-inch, factory slotted casing in the depth interval of 345 to 355 feet. A sand pack was installed around the casing in the depth interval of 340 to 355 feet. The product "Hole Plug" was installed

from land surface to a depth of 340 feet. Eight-inch diameter surface casing was installed to a depth of about 10 feet and equipped with a locking cap. The reported yield by the driller was 50+ gpm. The reported depth to water was 140 feet below ground surface. The geologic log prepared by the well driller is provided below.

|                 |                               |
|-----------------|-------------------------------|
| 0 to 2 feet     | fill rock                     |
| 2 to 10 feet    | brown top soil                |
| 10 to 19 feet   | loamy-tan clay                |
| 19 to 23 feet   | yellowish-tan clay with sand  |
| 23 to 43 feet   | broken basalt                 |
| 43 to 50 feet   | whitish tan clay              |
| 50 to 58 feet   | honey basalt                  |
| 58 to 61 feet   | light grey soft basalt        |
| 61 to 110 feet  | hard basalt                   |
| 110 to 116 feet | basalt with water, 5 gpm      |
| 116 to 245 feet | hard basalt                   |
| 245 to 249 feet | broken basalt with rounds     |
| 249 to 280 feet | hard basalt                   |
| 280 to 301 feet | sand, lots of water           |
| 301 to 304 feet | hard grey clay                |
| 304 to 345 feet | sand with clay seams and wood |
| 345 to 348 feet | hard clay with basalt         |
| 348 to 355 feet | sand with water               |

### **Grande Ronde Well**

This well was constructed at the West Drilling Site to a total depth of 735 feet using a sequence of air rotary, mud rotary, and then air rotary drilling techniques. Twelve-inch diameter temporary steel casing was installed was driven to a depth of 60 feet. A 12-inch diameter open hole was drilled through the basalt. The drilling rig was then converted for mud rotary operations. The well was drilled open hole to a depth of about 730 feet. Eight-inch diameter steel casing was placed to a depth of 730 feet and then pressure grouted in place using a cement grout. The temporary 12-inch diameter casing was removed at this time. No additional casing was installed. The 8-inch diameter casing was equipped with a locking cap. The reported yield by the driller was 300 gpm. The reported depth to water was 372 feet below ground surface. The geologic prepared by the well driller is provided below.

|                 |                                    |
|-----------------|------------------------------------|
| 0 to 2 feet     | fill rock                          |
| 2 to 8 feet     | dark brown clayish soil            |
| 8 to 19 feet    | tan clayish soil                   |
| 19 to 43 feet   | yellow clay with sand              |
| 43 to 50 feet   | white clay with water              |
| 50 to 63 feet   | broken basalt honey combed         |
| 63 to 110 feet  | hard basalt                        |
| 110 to 115 feet | fractured basalt with water, 6 gpm |
| 115 to 245 feet | hard basalt                        |

|                 |                                   |
|-----------------|-----------------------------------|
| 245 to 248 feet | fractured basalt with water       |
| 248 to 277 feet | hard basalt                       |
| 277 to 293 feet | sand with water, 100+ gpm         |
| 293 to 365 feet | sand with tan clay seams          |
| 365 to 371 feet | sand and wood with water          |
| 371 to 422 feet | clay with sand                    |
| 422 to 460 feet | brown clay with sands             |
| 460 to 500 feet | brown hard clay                   |
| 500 to 582 feet | grey basalt                       |
| 582 to 597 feet | hard basalt                       |
| 597 to 627 feet | blue clay                         |
| 627 to 643 feet | basalt                            |
| 643 to 686 feet | sand, quartz with clay seams      |
| 686 to 725 feet | dark brown clay with basalt chips |
| 725 to 730 feet | broken basalt with water          |
| 730 to 735 feet | broken basalt with water          |

### **GEOLOGY AS INTERPRETED BY DR. JOHN BUSH**

#### **Grande Ronde Well**

Depth in feet

0-2-----Top soil, dark dusky brown (5 yr 2/2).

#### **LATAH FORMATION** Sediments of Bovill

2-30-----Clay, dark yellowish brown (10 yr 4/2), slightly silty.

35-50-----Clay, white (N9) to yellowish gray (5 yr 7/2).

#### **WANAPUM BASALT** Priest Rapids Member-Lolo chemical type

50-60-----Basalt, vesicular, fine-grained, medium-gray (N5), iridescent coatings common.

60-70-----Basalt, vesicular.

70-110----Basalt, dense, fine to medium-grained, occasional plagioclase phenocryst,  
medium-gray (N5), fractured at 110 ft.

110-245---Basalt, dense, same as above.

245-247---Basalt gravels, 2-3cm, angular to sub-rounded, same as host rock, interpreted  
as non-depositional.

247-276---Basalt, dense, fine to medium-grained, occasional plagioclase phenocryst.

#### **LATAH FORMATION** Vantage Member

276-278---Sand, coarse to very coarse (1/2mm to 2mm), 90% quartz, 10% basalt?,  
minor muscovite and feldspar?, subangular to subrounded, sample mixed  
with chips from above.

278-285---Clay, white (N9) to very light gray (N8).

285-290 ---Sand, very coarse (1.5-2mm), 90% quartz, 10% basalt ?, minor muscovite,  
subrounded, fairly well sorted, rare wood fragments.

290-335---Sand , silt and clay, occasional granule of quartz and some subrounded basalt (3-5%). Abundant wood fragments and sample sticky 299-305 feet.  
335-360---Sand, silt, and clay, greenish gray clay in overflow ditch but not in samples.  
Sand is coarse to very coarse-grained  
360-370—Clay, brownish gray (5YR 4/1), sandy?, abundant wood fragments.  
370-410---Sand, coarse .5 to 1mm to very coarse (1.5mm), subangular to subrounded, fairly well sorted with silt and clay, minor wood fragments with some abundant intervals, color of mud is greenish gray, abundant silt in overflow ditch after drilling, occasional very fine-grained well rounded siltite granule.  
410-423---Sand, slightly coarser than above.  
423-485---Clay and silt, mud a moderate brown (5 YR 4/4) in color.  
485-499---Clay and silt, mud a grayish yellow green (5GY 7/2) in color.

GRANDE RONDE BASALT  
N2 Member

499-510---Basalt, vesicular with small openings, iridescent coatings.  
510-580---Basalt, dark gray (N3), very fine-grained, dense.  
580-585---Basalt, dark gray (N3), vesicular and iron stained, minor vesicle fillings.

LATAH FORMATION

585-620---Clay, grayish green (10GY 5/2), silty in places.  
620-665---Sand, coarse to very coarse (1/2mm to 2mm), subangular, 95% quartz with siltite, basalt?, and minor muscovite fragments.  
665-720---Clay, brownish gray (5YR 4/1), silty in places.

GRANDE RONDE BASALT  
R2 Member

720-735---Basalt, dark gray(N3), very fine-grained.

**Sediments of Bovill Well**

Depth in feet  
0-8-----Top soil, dark dusky brown (5 yr 2/2).

LATAH FORMATION  
Sediments of Bovill Member

8-19-----Clay, dark yellowish orange (10 yr 6/6), slightly silty.  
19-25-----Granule gravel, 2mm to 6mm, average 4mm, occasional pebble 10-20mm, very angular to subangular, 99% quartz, minor muscovite and feldspar, most grains transparent, very light gray (N8) to yellowish gray (5y 8/1), water bearing. Samples are stained and contain yellow clay. Percent clay undetermined, but believed to be relatively high.

SADDLE MOUNTAINS BASALT  
Weissenfels Ridge Member-Lewiston Orchards Flow

25-35-----Basalt, fine-grained, occasional plagioclase phenocryst 3-4mm, medium dark gray (N4), Fe and Mn stains on uppermost and lowermost chips.

LATAH FORMATION  
Sediments of Bovill Member

- 35-40-----Clay, pale blue (5B 6/2) with white (N9) centers, when wet color changes to blue and generally recorded as blue clay by most drillers, very slick.
- 40-47-----Clay, varied colored, yellowish gray (5yr 7/2) to pale yellowish orange (10yr 8/6), minor black streaks (N1), approximately 10% silt and very fine sand.
- 47-58-----Clay, pale yellowish orange (10 yr 7/2), very slick.
- 58-70-----Granule gravel, 3-5mm, coarser in places 6-7mm, occasional 10-15mm pebble, 99% quartz, minor muscovite and feldspar, subangular to subrounded. Samples stained yellow and contained yellow clay. Not possible to estimate percent of clay.
- 70-72-----Clay, pale yellowish orange (10 yr 7/2).

Figure 1 Location Map

