Naylor Farms Geology Hearing

IDWR Permit No. 87-10022 in the Name of Ralph Naylor Farms, LLC

Testimony by William J. Elliot, PE, PhD
In Support of Dr. Lois Blackburn, Intervenor

1. Purpose

This document is intended to contribute to a hearing on the geologic considerations of the Naylor Farms, LLC application for a water permit. The Farms requested a water permit to extract up to 599 acre ft of water, with a maximum pumping rate of nearly 2,000 gal/min from a site located adjacent to Foothill Road, about 3 miles north of Moscow, ID.

The testimony is arranged in several sections, with the purpose of each section as follows:

1. Present an overview of the testimony
2. Present the background and qualifications of Dr. Elliot
3. Review the public record of the Naylor Farms, LLC proposal for a water permit (IDWR 2004b)
4. Synthesize information about connectivity and availability of groundwater resources in the vicinity of the Naylor farm from well log information
5. Estimate aquifer hydrologic properties from well log data, and use that information to determine impact of proposed pumping on nearby wells.
6. Present a summary of concerns of local residents about their own groundwater resources.
7. Summarize the information presented, and draw conclusions about connectivity and availability of groundwater resources in the vicinity of the proposed Naylor test site.

Three appendices are attached:

A. Selected well logs to serve as examples or provide specific information in support of a given analysis.
B. Summary of all well log information used in analysis
C. Information on general declining water levels in the area.

2. Elliot's Background

Section 2 presents the background and qualifications of Dr. Elliot.

Dr. Elliot currently lives about 1/2 mile north of the proposed Naylor well site (Figure 10). He has a farming background, and a keen interest in farming and maintaining a rural lifestyle for himself, and for other county residents who share such values.

2.1 Education and Registration

Dr William J. Elliot received his BS and PhD in Agricultural Engineering from Iowa State University. His MSc degree in Engineering is from the University of Aberdeen, Aberdeen, Scotland. Dr. Elliot is a registered professional engineer in the State of Ohio, Registration Number E-53801.

2.2 Experience

Dr. Elliot has worked in teaching, research, and/or extension in Kenya, the Bahamas, Scotland, Liberia, England, Iowa, Ohio, and for the past 12 years in Idaho. He is currently a project leader for the Soil and Water Engineering Research Work Unit, Rocky Mountain Research Station, of the USDA Forest Service. His current research interests include hydrology and soil erosion processes and prediction in forest environments.

2.3 Publication Record

Dr. Elliot has been one of the lead authors or editors of the following books:

Ward, A. D., and W. J. Elliot (Eds.). 1995. *Environmental Hydrology*. Boca Raton: Lewis Publishers. 462 p.

Schwab, G. O., D. D. Fangmeier, W. J. Elliot, and R. K. Frevert. 1992. *Soil and Water Conservation Engineering Fourth Edition.* New York: J. Wiley and Sons. 507 p.

Schwab. G. O., D. D. Fangmeier and W. J. Elliot. 1995. *Soil and Water Management Systems Third Edition.* New York: John Wiley and Sons. 371 p.

In addition to the above books, Dr. Elliot has authored or coauthored about a hundred research articles, conference proceedings, and book chapters. Most of the topics are related to soil and water engineering.

3. Review of Naylor Materials

Section 3 presents a review of the geology aspects of the public record of the Naylor Farms, LLC proposal for a water permit (IDWR 2004b).

On December 1, 2004, the Idaho Department of Water Resources (IDWR) (2004a) granted the Naylor Farms, LLC, a preliminary permit to pump no more than 0.02 cfs per acre nor more than 3.0 acre-ft per acre for 199 acres. On December 28, 2004, IDWR reconsidered that order and subsequently scheduled a hearing for April 6 and 7 to receive testimony limited to only geologic aspects related to that permit.

The flow rate (0.02 cfs/acre) is over **1,800 gpm**. This maximum figure will be compared to observed pumping rates throughout this document.

The review of the Naylor materials (IDWR 2004b) will be limited to the geologic information as specified by the Hearing Officer. This does not imply that the other information in the Naylor proposal is adequate to address the issues the Department has already considered in this matter (IDWR, 2004a)

3.1 Documents Showing Location of Adjacent Wells (Exhibit 10)

The information provided in Exhibit 10 was limited to depths of wells only, and no development of the implications of the well data was made. Some of the material was duplicated, and many of the pages were truncated, so that critical information necessary for analysis was missing. The material was sufficiently disorganized that it was not possible to discern:

- The location of many of these wells,
- The depths of many of the wells
- The underlying geology of the aquifers
- The capacity of the wells

As this information was not adequately presented and summarized, it is not possible to judge whether the Naylor application meets IDWR (2004a) issue 4.b. addressing the sufficiency of the water supply for the intended purpose.

3.2 Geology Discussion (Exhibits 11a and 11b)

The geology discussion begins with a considerable amount of background discussion of little relevance obtained from a reference (*Roadside Geology of Idaho*). The text is intended as a layman's guide, and was never intended to be highly accurate at specific locations. The figures cited in the text do not directly correspond to the figures in the presentation, making it difficult to interpret what information is provided.

3.2.1 Differences in Static Water Level

The 200 ft difference in water levels between the Naylor site and the city of Moscow, described on page 4, paragraph 2 does not necessarily support the conclusion that there are separate basins. A well log study described later in this deposition calculated the average static water level in each section in a north-south profile through the Naylor site. The static water level is shown in Figure 1, where it is clear that the gradient of the static water table tends to follow the general level of the ground. In addition, Paradise Creek runs adjacent to the Naylor site, and also runs through the center of Moscow, providing a direct surface hydrologic linkage between the sites. Exhibit 11a provided no solid data to support any disconnect between the Naylor site and the city of Moscow, only vague generalities. **Hence, the IDWR (2004a) Conclusions of Law, Number 4, that the proposed water withdrawal is from a separate source of water can not be made unless additional information is provided to support this statement.**

3.2.2 Basin Area Calculations

The discussion on basin areas used a very crude method of determining areas, and resulted in a gross miscalculation of area. In Exhibit 11a, page 7, the area of the "Naylor

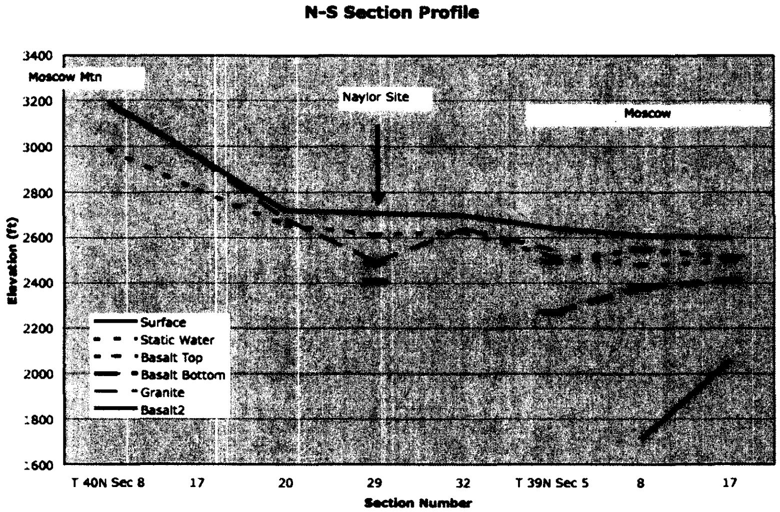

Figure 1. North-South profile through the proposed Naylor well site.

Basin" is given as 125 sq mi, and the "Moscow Basin" as 107 sq. mi. Simply counting the sections in the "Moscow Basin" in Figure 2 results in an approximate area under 4 miles by 7 miles, or less than 28 square miles, and the "Naylor Basin" is similar. The gross errors in the Naylor Exhibit mean that none of the water balance calculations on page 7 of Exhibit 11a are correct, nor are any calculations associated with the amount of available water. One component of any groundwater management plan is a sound hydrologic budget including an areal water balance (Freeze and Cherry, 1979), and this major error in estimating area makes this section of the proposal unacceptable. This calculation must be redone before it can be concluded that the water supply is sufficient for the purpose intended. **Hence, Conclusions of Law number 5, (IDWR, 2004a), that the water supply is sufficient, can not be made until these areas are correctly calculated.** The dropping static water levels in the Moscow-Pullman basin are strong indicators that current recharge is inadequate (Ralston, 2004), so it is unlikely that even if a water balance was carried out that it would find sufficient recharge to support the permitted abstraction.

3.2.3 The Existence of Sub-Basins

Exhibits 11a and 11b develop a theory that there are distinct sub-basins separating the proposed Naylor development site from the Moscow-Pullman well sites. Arbitrary lines were drawn between the Moscow Sub Basin and the Naylor Sub Basin shown in Slide 26 in Exhibit 11b. The dividing line shown, however, is crossed by numerous streams

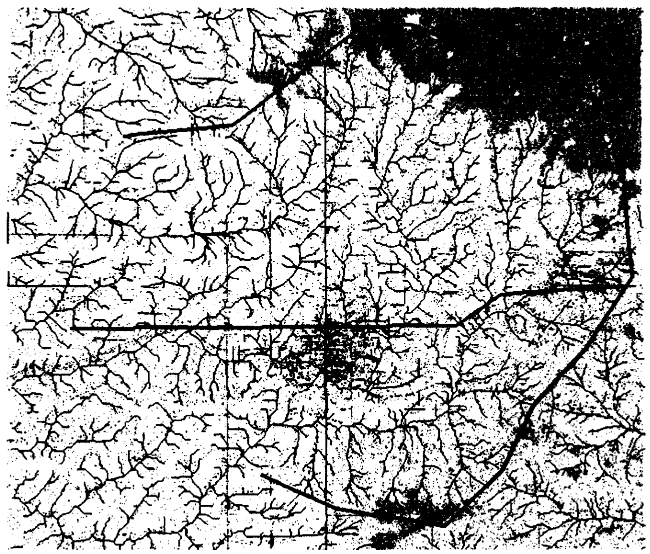

Figure 2. Stream network and approximate suggested basin borders from Exhibit 11b

including the South Fork of the Palouse River in the East, and Paradise Creek in the center, of this basin division line (Figure 2). Clearly there is a surface water connection between these two sub basins at a minimum. There are no subsurface data presented in the Naylor exhibits to support the claim the two sub basins are hydrologically disconnected, only some vague geologic discussions from maps and observed landscaping in the area. Generally, in this area, surface channels tend to flow in the same direction as underlying geologic features, so it is likely that if surface water is crossing between these two "basins", that there will be substantial groundwater links as well. The conclusion drawn in Exhibits 11a and 11b, that the "Naylor Sub-Basin" and the "Moscow-Pullman sub-Basin" are not accessing the same water is not valid. **Hence, the IDWR (2004a) Conclusions of Law number 3, that suggests little interconnection, is not correct. There is unquestionable surface connection between the Naylor Site and the cities of Moscow and Pullman, and quite likely a subsurface connection as well.**

3.2.4 Evapotranspiration Calculations

The Naylor application letter dated April 12, 2004, raised major concerns about whether the application was made in good faith when the letter discussed "transevaporation" numerous times. This is not a word. The applicants likely meant "evapotranspiration". The applicants also described how excess water would "matriculate" back into the soil. Again this is the incorrect word, as water either "infiltrates" in to the soil, or "percolates" through it. The inability of the applicants to use the correct hydrologic terms raises serious questions about whether they have any idea about irrigation management, and whether this application is intended to use the water for irrigation. This lack of knowledge of the science of irrigation raises serious questions about Issue number 4 in the IDWR (2004) Findings of Fact. **This application does not appear to have been made in good faith.**

On page 6 of Exhibit 11a, the evapotranspiration is estimated using the evaporation pan method. The pan method is intended to estimate water needs during the growing season, and is not intended to be used for estimating total annual evapotranspiration (Ward and Elliot, 1995). Not only was this an inappropriate application of the evaporation pan method, but the exhibit did not define some key variables (L and Lo), and there was a major conversion error (converted centimeters to meters rather than millimeters to meters) in the final calculation, so it was off by a factor of ten. The presentation accompanying Exhibit 11a (Exhibit 11b) presented another method of estimating evapotranspiration as simply 0.4 times the annual rainfall. There is no reference to support this estimation method, nor is this a generally accepted method for estimating evapotranspiration. Evapotranspiration is far less dependent on annual precipitation than it is on temperature and solar radiation. Hence, this method for estimating evapotranspiration is not valid either. Exhibit 11a used the incorrect calculation for estimating evapotranspiration on page 6 for the water balance calculation on page 7. Since the evapotranspiration calculation is invalid, so is the water balance. Estimation of evapotranspiration must be done correctly before it can be determined that:

- There is adequate long term availability of groundwater, and
- The amount of irrigation water requested can be beneficially applied.

Hence, the IDWR (2004a) Conclusions of Law, number 5, that the water supply is sufficient can be made only if a correct water balance is completed to establish that there is adequate recharge in the area to sustain the desired withdrawal amount.

In the IDWR (2004a) Analysis section, IDWR stated that the intervenors' concern that the applicant had applied for more water than could be beneficially used was not well based. The intervenors' concern was, in fact, very well based. As discussed above, the applicants had so many errors in the area and water balance calculations than no conclusions can be reached. With so many errors, there is no way of determining how much water could be beneficially used. **Thus, the intervenors' concern was very well based, and with so many mathematical and scientific errors, this application can not be considered to have been made in good faith, a requirement in Findings of Fact 3.c (IDWR 2004a).**

3.3 Well Log of Naylor Farms Test Hole (Exhibits 11 and 12)

Three different Exhibits were presented to describe the Naylor Farms Test Hole. Many references in the Naylor exhibits record that the data in exhibits 11 and 12 were all collected between August 30, 2003, and September 3, 2003 (e.g. page 1, Exhibit 12). These dates are clearly confirmed by the Target Drilling Inc. Daily Time Report (Exhibit 12a), with travel starting on August 28 and drilling starting on August 30. On September 3, however, there is a major difference within the exhibits. Exhibit 12, the Diamond Drill

Log, records that the depth of drilling was 470 feet. The Target Drilling Daily Time Report says that the drilling made it only to 211 feet by September 3, at which time the bit was "worn out and shank-broke off" and then "Rods sanded in at 211' – work up and down no avail." To further confound the interpretation of this test hole, less than 370 feet of cores are presented from an alleged 470-foot deep test hole.

Several major areas of concern are raised from Exhibits 12, 12a, and 12b. They include:

- The Drill log states the final depth was 470 ft, and the Time Report says the final depth was 211 ft, both reached on September 3
- The Drill Log says that basalt was encountered between 190 ft and 273 ft, a total thickness of 83 ft; the Time Report makes no mention of basalt before it quit at 211 ft.
- The cores appear to have a total thickness of basalt of 113 ft, not 83 ft as stated in the Drill Log.
- The labeling of the cores is so poor that it is not possible to determine the depths from which they came, or at what depth the basalt begins.
- The Drill Log and the Time Report both state that an HQ core size was used (63 mm dia), but the cores appear to have at least two different diameters (See Exhibit 12b, pages 7, 16, 17, and 19)
- The initial basalt cores do not show the usual cracking and fracturing associated with the top of most basalt formations (Freeze and Cherry, 1979) (See Figure 5).
- There was no description of the water-bearing properties of the basalt.
- The alleged purpose of the core drilling was to evaluate groundwater potential, and yet no mention is made in the exhibits of any test pumping, or of any of the aquifer properties associated with groundwater development, such aquifer porosity and hydraulic conductivity.

In light of the above concerns, the **IDWR (2004a) Conclusion of Law, number 6, is not supported in that the core drilling has so many inconsistencies that it does not provide the information necessary for examining the potential of obtaining a suitable water supply**. Also, **the Findings of Fact Number 8, stating that one well was drilled to a depth of 470 feet can not be supported by either the Target Drilling Daily Time Report, nor by the length and labeling of cores intended to support this fact**. Thus, this Finding is not validated by the information provided, nor can any other conclusions be drawn from this alleged depth without independent confirmation of the depth and material beneath the Naylor site.

3.4. Proposed Protocol for Aquifer Impact (Exhibit 37)

The proposed protocol (Exhibit 37) assumes that nearby domestic wells and more distant municipal wells will respond quickly to pumping by Naylor Farms. Previously published pumping tests from the deeper Grande Ronde aquifer showed rapid responses in wells between Moscow and Palouse (McDonough, 2003). In the case of the Naylor well, which would be in the more shallow sediment layers, however, the aquifer consists of layers of sand embedded in layers of clay. The vertical hydraulic conductivity is very

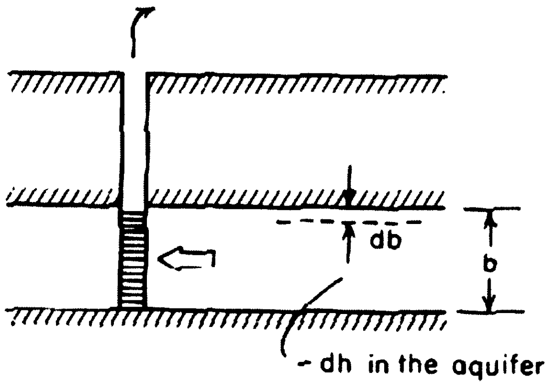

Figure 3. Aquifer compaction caused by groundwater pumping (Freeze and Cherry, 1979).

low in these cases (Smoot, 1987), and response time will likely be in the order of days to weeks, rather than hours.

Static water levels have been declining in this area for many years (Appendix C, Ralston, 2004). This general decline will tend to make it difficult to discern static water level decline as a direct result of the increase in pumping from the Naylor Farms. Also, year to year fluctuations in the static groundwater level are also dependent the weather, particularly in the more shallow private wells surrounding the Naylor site.

If the Naylor aquifer is sandwiched between the Wanapum basalt and granite, then it is a confined aquifer as shown in a simple diagram in Figure 3. The upper layer would be basalt, and the bottom layer granite. The proposed Naylor pumping will be from an aquifer between these two layers with a thickness of b in Figure 3. Water yields from confined aquifers are low for the corresponding drop in head, because the aquifer is actually compressing as water is removed, as shown by "db" in Figure 3 (Freeze and Cherry, 1979). Major pumping is likely to lead to a permanent deformation of the aquifer. Once the deformation occurs, confined aquifers seldom recover their prepumping hydrologic characteristics.

The proposed protocol raises several matters of concern.

- Duration of test pumping period is not stated,
- Duration of monitoring is limited to one year and vague thereafter
- Methods for logging nearby domestic wells is vague
- Static water level in area is already declining, so it will be difficult to establish any additional decline is due to Naylor pumping.
- If a well is in a confined aquifer beneath the basalt layer, excessive pumping can lead to compaction of this aquifer, **permanently** reducing water holding and water yield capabilities of the aquifer

Thus, if the proposed protocol is followed and halted some months or even a year after it was started because of offsite impacts, the water bearing strata may never recover.

In addition to the above concerns, the IDWR (2004a) Order Number 10 states that "Use of the water under this right may be affected by an agreement (termed protocol in this matter) between protestants and the right holder." The word "may" rather than "shall" or similar term means that even if the protocol is followed and connectivity is proven, Naylor farms are not obliged to stop pumping. **Hence, the protocol is lacking in scientific rigor and longevity to protect current users' primary water rights, and order Number 10 is lacking in authority to uphold the protocol.**

4 Well Log Qualitative Analysis

Section 4 presents a synthesize information about connectivity and availability of groundwater resources in the vicinity of the Naylor farm from well log information.

The Exhibits provided by Naylor Farms were not considered sufficient to evaluate the groundwater resources in the vicinity of the Naylor site nor the connectivity of this site to other rural wells in the area and to the large municipal wells of the Cities of Moscow and Pullman, and the two universities. The generalized discussion of the geology of the area based on a popular reference (Roadside Geology of Idaho), and the concerns about the Naylor test hole as discussed in section 3.3 mean that additional data need to be considered to evaluate the groundwater impacts of the Naylor water permit request.

In order to better understand the local groundwater resources, more than 160 well logs for wells within about three miles of the Naylor site were obtained from the Idaho Dept. of Natural Resources (2005). These wells provided an excellent overview of the groundwater resources surrounding the Naylor site. For the sake of brevity, only typical well logs will be presented with this testimony in Appendix A. A summary of all the well logs considered is presented in Appendix B. Data from all wells obtained have been included in this deposition, not just a selection to support this writer's point of view.

Figure 4 provides a general overview of the location of the Naylor site, and the type of material found in each of the aquifers. It does not contain locations of all 160 wells, as some were off the map, and others were so close together it was difficult to differentiate the wells. It does, however, present a picture of the distribution of aquifer materials in the vicinity of the Naylor site.

4.1 Properties of groundwater aquifers in the Naylor vicinity

There are four geologic materials that dominate the area: deposited sediments, two layers of basalt flows, and granite bedrock. Table 1 shows the distribution of aquifer materials recorded in 160 well logs (Appendix B), generally within three miles of the Naylor site. The entire area is covered with a silty clay loess. The loess is not suitable for groundwater development, and its low hydraulic conductivity and high anisotropy

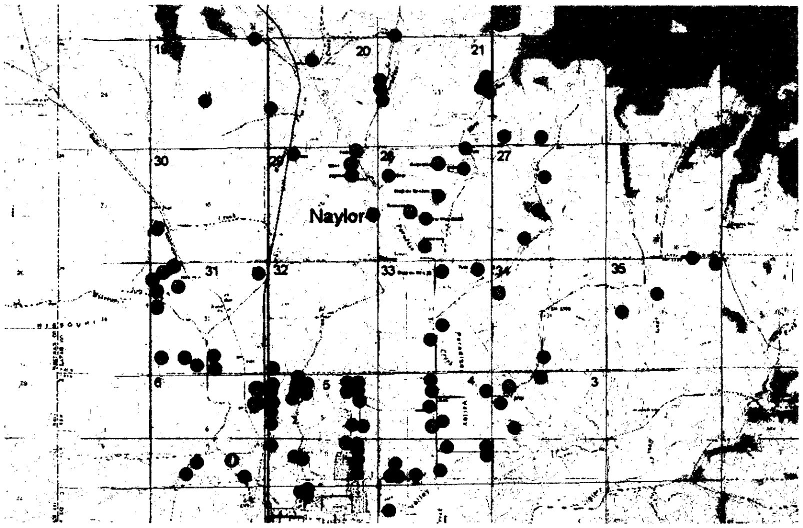

Figure 4. Map of the area surrounding the Naylor site, section numbers, and location and material of some of the wells. Black dots are in basalt, yellow (or white) dots are in sediments, orange (or gray) dots are in granite or decomposed granite, and dots half black and half yellow are in sediments beneath the Wanapum basalt layer. Section lines are shown along with section numbers for T39N, R5W in the south and T40N, R5W in the north.

(horizontal hydraulic conductivity is greater than vertical conductivity) limits the recharge of the aquifers below (O'Brien, 1996).

4.1.1 Sands and Clays

The deposits of sands and clays are in layers leading to a high degree of anisotropy, with the clay layers restricting the movement of water vertically through the soil. Water can, however, move relatively rapidly horizontally in sand layers (Freeze and Cherry, 1979; Smoot, 1987). Water in these aquifers tends to concentrate in lenses of sand or gravel. Locally, yields can be quite high, but volumes may be limited many of these lenses do not cover large areas (Freeze and Cherry, 1979).

4.1.2 Basalt

The basalt layers tend to have high hydraulic conductivity and high water bearing capabilities near the upper surface, but tend to resist flow and hold little available water in the center of the layers (Freeze and Cherry, 1979). Thus, little water moves through the layers, but water in the upper layers is readily available at moderate flow rates for

Table 1. Materials in aquifers in wells within about three miles of the Naylor site.

Material	No. of Wells	Percent of total	Avg Depth (ft)	Avg Yield (gpm)
Decomposed Granite	34	21.3	207	8.5
Granite	38	23.8	298	8.9
Sediment above basalt	15	9.4	119	7.7
Quartz	9	5.6	180	12.0
Wanapum basalt	43	26.9	206	27.3
Sediment beneath Wanapum	20	12.5	324	78
Grande Ronde basalt	1	0.6	1305	1150

domestic use. Within the basalt layers, water tends to preferentially move in the direction of the original basalt flow. For example, Figure 5 shows a spring line coming out of a basalt flow in the original direction of the basalt flow, from west to east in this case. The basalt on the opposite side of the road had no such water flowing from east to west.

The importance of this condition is that if there is a layer of basalt beneath the Naylor site (Section 3.3 presented concerns that there may not be), then it is the very north end of such a flow as no basalt was observed on any of the adjacent wells. The IDWR (2004a) Conclusions of Law Number 4 states "If Naylor Farms installs unperforated well casing through the Bovill sediments located above the Wanapum basalt and seals the casing into the Wanapum basalt, Naylor Farm's (sic) pumping will essentially be from a separate source of water and will not reduce the quantity of water available to existing wells in the area." This is not true. If the Naylor well is sealed into the basalt, preferential flow from the south to the north will likely dewater all of the basalt wells in T39N sections 4, 5, and 6 (Figure 4). Twenty-nine well logs were downloaded from these three sections that pumped water from the basalt (e.g. Appendix A, Well A.1), including three that required redrilling, (Appendix B), and three municipal wells (Appendix A, Well A.2 and A.3). **Hence, the Conclusions of Law (IDWR 2004a) Number 4 that sealing a well into the Wanapum Basalt will provide water from a separate source is not supported by the evidence provided by the Naylor test hole, nor by the hydrogeology of basalt aquifers, nor by the well log data in the area.**

4.1.3 Granite and Decomposed Granite (DG)

The granitic aquifers generally produce little water. These aquifers rely on cracks and fissures to supply water. Generally, the deeper a well goes into granite, the less likely it will find water as the weight of the granite tends to prevent cracks from forming (Freeze and Cherry, 1979; Kaal, 1978). Figure 6 shows the relationship between the estimated

Figure 5. Spring line from a basalt flow near Rosalia, WA, preferentially flowing in the same direction as the original flow. Note also the higher degree of cracks nearing the surface of the basalt (Photo by W. Elliot).

well discharge and the depth of the well from 38 granitic wells within three miles of the Naylor site, confirming this correlation. Deeper wells do not produce more water, and in fact, Figure 6 shows that they are more likely to produce no water. Granite formations decompose with weathering into decomposed granite (DG). Decomposed granite aquifers tend to be more shallow than wells into unweathered granite. The makeup of decomposed granite is both sand and clay particles, and so the hydrologic properties of decomposed granite aquifers can vary widely, with the well logs estimating discharge in DG from less than 1 to more than 10 gal/min (Figure 7).

The implications of this condition are that **if the granitic aquifers upslope and to the north of, the Naylor Farms site (Figure 4) are dewatered by downstream pumping, it is unlikely that the well owners in those areas will be able to simply drill deeper to find a new source of water**. In any case, these owners should not be forced to redrill if the protocol works, and the aquifers are not permanently damaged in the protocol period (Section 3.4).

4.1.4 Sediments Beneath First Basalt Layer

Twenty of the 160 wells analyzed were drilled into sediments below the upper basalt layer (Table 1), generally referred to as the Wanapum basalt. Included with these 20 wells are 2 Moscow municipal wells (Appendix A, Wells A.4 and A.5) and 17 private

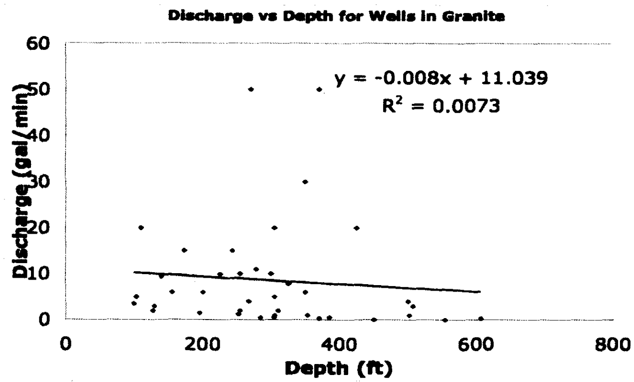

Figure 6. Discharge as estimated on well logs vs depth of well for 38 wells drilled in to granite aquifers within three miles of the Naylor site.

wells (e.g. Well A.6). Although well logs were not available, the University of Idaho also abstracts water from these layers (Kopp, 1994). The letter from Naylor Farms dated April 12, 2004, on page 14 states "our intent is to drill a well about 470 feet deep, thus avoiding the conflict with existing nearby farms." The well logs clearly show that such a well will not avoid conflict as there are many wells pumping from the sediment layers below the Wanapum basalt, the intended source of the large groundwater abstraction for the Naylor site. Major pumping from these sediment aquifers will likely have major impacts on the 20 other wells pumping from these same layers. **Hence, the IDWR (2004) Conclusions of Law Number 4, that states "Naylor Farm's (sic) pumping will essentially be from a separate source of water and will not reduce the quantity of water available to existing wells in the area" is not valid.**

4.1.5 Well Yields from Different Aquifer materials

Figure 7 shows the general relationship between material, depth, and well yield for all of the well logs. The highest yielding wells were Moscow municipal wells drilled into the upper basalt layer (Wanapum), Other high yielding wells tap into sediments beneath the upper Wanapum basalt, the aquifer that the Naylor proposal seeks to access, and the lower basalt aquifer, the Grande Ronde. Figure 7 only shows one of the Moscow wells drilled in to the lower basalt layer, the Grande Ronde. There are other municipal wells for Moscow and Pullman that access the Grande Ronde, but their logs were not available through IDWR (2005). The lowest yielding wells are in granite and decomposed granite aquifers, although some decomposed granite aquifers have quite high yields. Note that there were only 5 out of over 160 wells that yielded more than 1,000 gal/min, and there were no wells that approached the 1,800 gal/min that was permitted by IDWR (2004a)

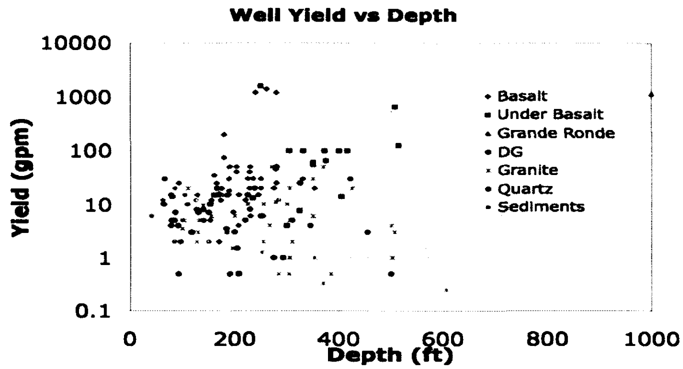

Figure 7. Well yield (gal/min.) vs. well depth (ft) for 160 wells in the vicinity of the Naylor well site.

Order number 8. All but one of the high yielding wells are for the City of Moscow (Appendix A Wells A.2, A.3, A.4, A.5, and A.7). The other high yielding well was for irrigation of the Sunset Memorial Gardens on the southeastern side of Moscow (Well A.8), adjacent to one of the Moscow municipal wells (Well A.5).

The Sunset Gardens well (Well A.8) was drilled in 1955 to 508 ft, and when test pumped, yielded 650 gal/min with a drawdown of only 64 ft. The nearby Moscow well was drilled in 1997 to 508 ft as well. This well, however, yielded only 100 gal/min with a drawdown of 83 ft. The well log commented "very poor producer" for this well. The static water level in the Sunset Gardens well was 124 ft, and the Moscow well level was only 5 ft deeper, at 129 ft. Although the water level had dropped only about 5 ft, the well yield had apparently declined by 84 percent. This is a major reduction in well yield over a 40 year period from the same aquifer from which the Naylor Farms are proposing to abstract large additional quantities of water. **Hence, the IDWR (2004) Conclusions of Law Number 4, that states "Naylor Farm's (sic) pumping will essentially be from a separate source of water and will not reduce the quantity of water available to existing wells in the area" is not valid.**

The accepted principal, that deeper wells will yield more (except in granite), is not generally the case this area (Figure 7). Because of the diversity of the aquifers, and the anisotropy of most of the materials, the yield of any given well is more a function of the conditions penetrated by the well than of any particular aquifer property.

Well yields shown in Figure 7 are based on the drillers' estimate of well capacity. In practice, these estimates tend to be overly optimistic, and well yields often decline with pumping. The prime example of this is Moscow Well Number 6 (Appendix A, well A.7),

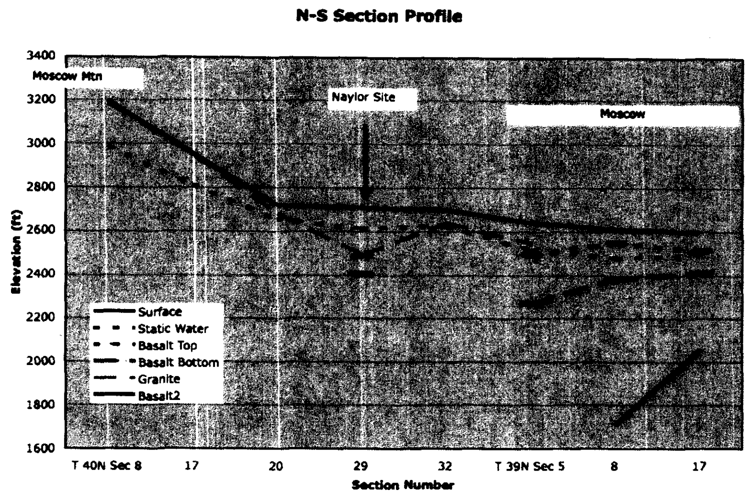

Figure 8. North-South profile through the proposed Naylor well site.

which yielded 1200 gallons/min. when it was originally test pumped, but which went dry within two years.

4.2 Qualitative Analysis of Well Logs

To understand the general relationship between the hydrogeology at the Naylor site and the surrounding areas, two profiles were drawn. The first was a North-South profile, beginning at Section 17 of Township 40N, Range 5W, in the Nearing Addition north of Moscow, and ending at Section 8, Township 39N, Range 5W, on the southern edge of Moscow (Figure 8). The second profile was carried out for an East-West profile, starting on the east at Section 27 of Township 40N, Range 5W, the area around West Twin Road, and ending at Section 25, T40N, Range 6W, with a single well at Estes (Figure 9). For each well within a section, the surface elevation, static water level, and elevations of granitic surface, and top and bottom basalt surfaces were noted. These elevations were averaged for each section.

4.2.1 North-South Profile

The average elevations by section of the underground properties for a North-South profile are shown in Figure 8. There was only a single well in Section 32, and it was in the southwest corner of the section. From the well map (Figure 4), it is apparent that in this vicinity, in the next section south, section 5, there are a number of wells in decomposed granite in the western part of the section, whereas there are a number of wells in basalt in the eastern part of the section. Hence the perception that the granite layer is above the

Table 2. Distance from the Naylor site, and depth to granite for wells that were drilled in to granite or decomposed granite.

Well	Section	Distance from Naylor site (ft)	Depth to Granite (ft)
Naylor Site	29	0	470
Adamski	29	2126	284
Clark	29	4738	163
Willis	28	4701	223
Cameron	28	2884	134
New Well	28	2395	100
Wilder	28	1942	77
Average w/o Naylor Test Hole		3131	163.5

basalt layer. The two dimensional nature of Figure 8 is not adequate to display all of the complexity of the aquifers in this area.

There is a major inconsistency between the well log data and the Naylor Test hole results in the depth to granite. Concerns were expressed about whether the test hole reached 470 feet in Section 3.3 of this testimony, and the well log information does not confirm this depth. Table 2 presents the depth to granite and the distance to nearby wells in the vicinity of the Naylor site. Figure 10 shows the location of the wells with respect to the Naylor site. Table 2 shows that generally, the closer the wells were to the Naylor site, the smaller the depth to granite. These data suggest that the likely depth to granite beneath the Naylor site is probably less than 300 ft, confirming the concerns about depth of drilling expressed in Section 3.3.

4.2.2 East-West Profile

The results of the section by section analysis for the East-West profile is shown in Figure 9. As all of the wells in section 27 were in granite, as were wells downloaded from section 26 (Appendix B.2 and B.3), it was not considered necessary to extend the profile any further east. There were no wells in Section 30, and only one well in R6W, Section 25, so the right side of this profile is not well defined. In particular, it is not possible to determine whether the basalt under the wells in sections 4, 5, 30, 31, or 33 (Figure 4) extend to the Naylor site. There was no basalt in any of the other wells in the same section as the Naylor site (Section 29), and only one well in Section 28 had basalt. In Section 28, less than 1/4 mile east of the Naylor site, one newly drilled well encountered 220 ft of sediment and another encountered granite beneath about 100 ft of overburden (Appendix A. Well A.9). Neither of these two nearest wells to the Naylor site encountered basalt. The location of these wells is shown on Figure 10 as the Townsend and "New Well". There were no well logs for Section 32 south of the Naylor farm to aid in determining the extent of basalt formations in this area (Figure 4). As discussed in Section 3.3, the Naylor test hole results are too inconsistent to support the existence of a basalt layer in Section 29.

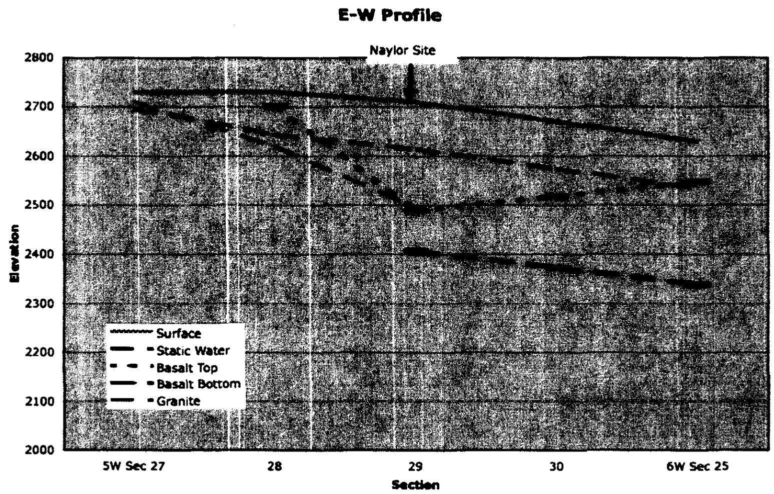

Figure 9. East-West profile through the Naylor Site.

4.2.3 Spatial Distribution of Aquifer Materials

A third qualitative analysis using the 160 well logs was to determine the spatial distribution of the aquifer materials. Figure 4 shows a number of the wells within about 2 miles of the Naylor site. Wells beyond those shown had aquifer materials similar to the wells on the edges of Figure 4. Figure 10 shows the distribution of some of the wells in the immediate vicinity of the Naylor site. Domestic wells near the Naylor site are in either in sediments or granite, with the nearest basalt wells 1/2 to 3/4 miles away. In Figure 4, wells more than 1/2 mile north of the Naylor site are in granite, wells south and southeast of the Naylor site are in basalt. Wells southwest of the Naylor site are generally in sediment layers beneath the basalt. Further south of the area shown on the map are some of the higher yielding Moscow municipal wells that are either in the Wanapum basalt (Appendix A, Wells A.2, A.3), sediments below the Wanapum basalt (Well A.5), or drilled into the Grande Ronde basalt layer below those sediments (Well A.7).

The two profiles (Figures 8 and 9) and the maps (Figures 4 and 10) show that uphill, to the north and east of the Naylor site are low yielding wells in granite or decomposed granite. The well records show that the average depth of these wells is over 200 ft deep, and the average yield less than 10 gal/min (Table 1). Any major pumping from the Naylor site will reduce the recharge rate of these aquifers as the water will likely preferentially flow laterally toward the Naylor site rather than percolate vertically to

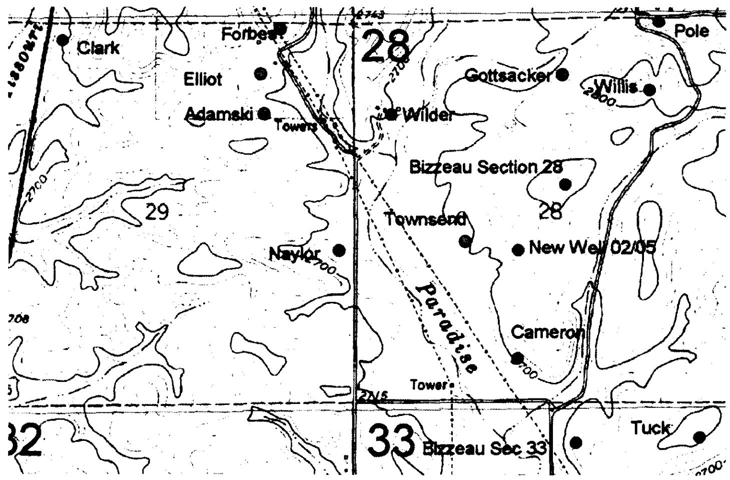

Figure 10. Detail of the location of wells and material as in Figure 4 in aquifers within a mile of the Naylor site

recharge these fragile aquifers (Kaal, 1978), and will likely lower the water table as will be demonstrated in Section 5.1.2 of the testimony. Because of the low hydraulic conductivity of the granite (Kaal, 1978), it will likely be a number of years before these sites begin to feel the full impact of the proposed Naylor groundwater abstraction and general increased rate of decline of the static water table in the area.

4.2.4 Moscow Well Number 6

One other observation from the well logs is from Moscow well Number 6 (Appendix A, Well A.7). According to the well logs, the city of Moscow drilled Well 6 in 1955 on the north edge of Moscow. The well appears to be similar to the proposed Naylor well, except that the diameter was 24 in. down to 20 in. It was cased through the upper sediments and into basalt at 126 ft. The main source of water was from "salt and pepper sand" beneath the basalt, at 250 ft depth. The capacity of the well was originally specified as 1200 gal/min. The "well went dry" within two years. The IDWR (2004a) Conclusion of Law point 5 stated "Based on available information, the water supply is sufficient for the purpose intended." **Based solely on this well, the IDWR (2004a) Conclusion of Law number 5 is incorrect**. The IDWR (2005) well log record for Moscow Well 6 clearly shows that it is highly unlikely that the applicant will be able to abstract water from a smaller diameter well at the rate in the preliminary order (up to 1800 gal/min). Therefore, this point must be removed from the preliminary conclusions unless further evidence can be presented showing why the Naylor proposal is sufficiently different from the Moscow Well 6 to support such a conclusion.

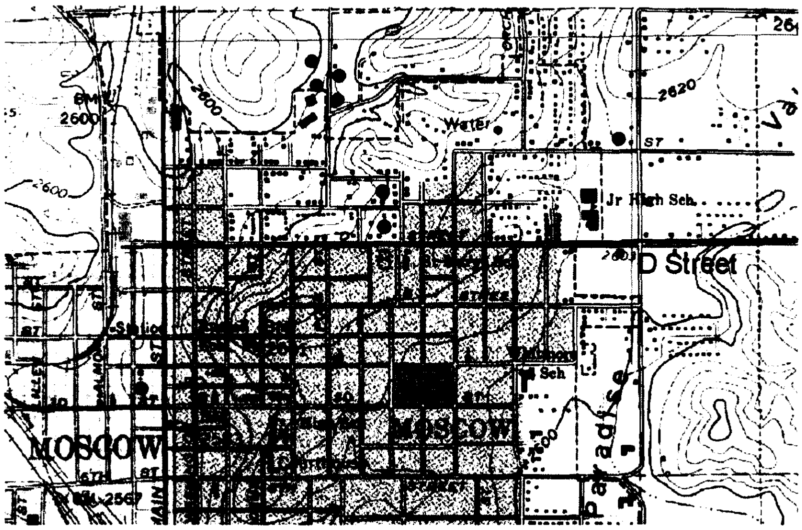

Figure 11. Wells in the vicinity of D Street in Section 8

4.2.5 Evidence for the "D Street Ridge" in the Well Logs

One of the key points made in the Naylor application was a "D Street Ridge" (Exhibit 13a), as this ridge would prevent any water abstraction at the Naylor site from impacting Moscow municipal wells south of D street. Figure 11 shows the location of D Street, and all of the wells that were on file at IDWR (2005) from Section 8 (T39N R5W). If this significant ridge exists, it should be readily apparent in the well logs for wells in the vicinity of D Street.

D Street is an east-west road that bisects Section 8 (Figure 11). Table 3 records the summary for all of the well logs for Section 8. It is clear in Table 3 that there is no indication of any material other than overburden closer than 40 ft from the surface. Below the overburden on all wells is a basalt layer, and no indication of material found only in Kamiak Butte as stated in Exhibit 13a. As stated in Section 4.1.2, basalts have a high degree of anisotropy, with horizontal hydraulic conductivity much greater than vertical conductivity, and water preferentially flows through basalts in the direction that the original basalt flow occurred. In this area, the basalt appears to have flowed from south to north (Figure 8), or in this case, north toward the Naylor site from Moscow. These results simply confirm what has been stated previously (Section 4.1.2), that any significant increase in pumping from the basalt layers north of the city will likely dewater all of these wells.

Table 3. Summary of all well logs in Section 8 (T39N R5W), the section that is bisected by D Street

Quarter	Material	Depth to Basalt (ft)	Well Depth (ft)	Static Water (ft)	Discharge (gpm)
NE NE	Basalt	130	148	30	10
NE NW	Basalt	87	180	90	3
NE NW	Basalt	-	240	20	1200
NE NW	Basalt	40	261	100	1400
SE NW	Sand under basalt	70	250	110	1585
SE NW	Sand under basalt	58	300	69	-

4.2.6 Summary of Conclusions from Qualitative Analysis

The results of this qualitative analysis clearly show that:

- If a basalt layer exists under the Naylor site, and stipulations within the IDWR (2004a) Conclusions of Law number 5 are followed - sealing the well in to the basalt - it is highly probable that the well will not provide the amount of water requested, and that a high level of pumping will very likely dewater at least 20 wells drawing water from the same aquifer.
- If the basalt layer exists, and the Naylor well passes through the basalt, as apparently proposed by the Naylor application letter dated April 12, 2004, then there are two Moscow municipal wells, at least 18 domestic wells within three miles of the Naylor site, and at least two university wells (Kopp, 1994) that will be directly impacted from such increased pumping.
- If the basalt layer does not exist, then there are numerous wells in the vicinity of the Naylor site that will be directly affected by major abstraction because of the strong anisotropy characteristic of alluvial aquifers. In time, increased pumping will likely dewater the fragile wells in granitic material north and east, upstream of the Naylor site.
- There is no well evidence of a "D Street Ridge" in the well log data, so there is no apparent barrier to isolate municipal, commercial, and domestic wells in southern Moscow from major pumping north of the city.
- There are no wells, municipal or otherwise, that are pumping at the rate allowed in the IDWR (2004a) order number 8 of over 1800 gal/min.

The above points clearly show for three different scenarios about the nature of the aquifer beneath the Naylor site, that the site is directly connected to scores of domestic, municipal, and university wells in all directions. Any major water abstraction from the Naylor site will impact these wells. **Hence, the IDWR (2004a) Conclusions of Law, Numbers 4 and 5 can not be made in light of this analysis of 160 well logs from IDWR (2005).**

5. Quantitative Analysis of the Impacts of the Proposed Naylor Water Abstraction

Section 5 estimates aquifer hydrologic properties from well log data, and uses that information to determine impact of proposed pumping on nearby wells.

When the initial permit was granted to the Naylor Farms, Dr. Elliot contacted IDWR requesting information on the pump tests from the Naylor Test Hole. He was informed that the IDWR would not provide him with that information. Later when the entire documentation for the Naylor application was obtained from other sources, it was evident that there was no test pumping on a test hole allegedly drilled to evaluate groundwater resources, showing a major shortfall in collecting data necessary to develop a groundwater resource. Fortunately, there were pump tests carried out on some of the wells in the IDWR (2005) well log inventory, and those tests have been accessed to gain insight into the hydrogeology of the area.

5.1 Aquifer properties

There are several important aquifer properties needed to evaluate well performance and offsite impacts of well pumping. These properties include:

- Hydraulic conductivity of the aquifer, and of the layers above and below the aquifer
- Thickness of the aquifer
- Diameter of the well
- Distance to nearby wells
- Whether the aquifer is confined or unconfined

5.1.1 Estimating Local Hydraulic Conductivity

For the well records available, the period of test pumping was short, lasting a few hours to a few days. With the high degree of horizontal anisotropy in all of the aquifers in this area, it is best assumed that the aquifers behave as confined aquifers during the short time for the test pumping period (Freeze and Cherry, 1979). Table 4 shows the drawdown associated with pumping for 11 wells in the vicinity of the Naylor Farm.

To gain an estimate of the hydraulic conductivity of an aquifer, one of the most commonly used equations is the Muskat Equation (Schwab et al., 1993). For a confined aquifer, the equation is:

Table 4. Pump test information for wells in the vicinity of the Naylor site (IDWR, 2005).

Well	Material	Well Depth (ft)	Dia (in.)	Yield (gpm)	Draw down (ft)	Thick-ness of Aquifer (ft)	Conduc-tivity K (ft/s)	Conduc-tivity K (m/s)
T39NR5W sec 3								
Koster	Sediments	140	8	8	30	18	1.49E-05	4.54E-06
T39NR5W Sec 4								
Carleton	Basalt	220	5	12	7	10	1.84E-04	5.61E-05
Moscow 250	Basalt	250	20	1585	80	156	1.10E-04	3.37E-05
Moscow No. 2	Basalt	240	20	1200	20	200	2.61E-04	7.95E-05
Moscow No. 3	Basalt	235	18	1400	20	195	3.18E-04	9.68E-05
T40NR5W sec 4								
Compton	Granite	310	8	5	30	6	2.79E-05	8.51E-06
Barrett	Granite	86	8	7	50	6	2.34E-05	7.15E-06
Hillestand	Granite	122	8	0.5	57	62	1.42E-07	4.33E-08
Moscow 514	Below Basalt	514	10	100	83	81	1.45E-05	4.41E-06
			10	125	214	81	7.01E-06	2.14E-06
Sunset Mem	Below Basalt	508	8	650	64	52	1.96E-04	5.98E-05
			8	203	12	52	3.27E-04	9.96E-05
Moscow No. 6	Lower Basalt	1305	10	1150	25	210	2.13E-04	6.49E-05

$$q = \frac{2\pi K b(H-h)}{\log_e(R/r)} \qquad (1)$$

where
- q = rate of abstraction (L^3/T),
- K = hydraulic conductivity (L/T),
- b = Thickness of the confined aquifer (L),
- H = height of the piezometric surface above the top of the water-bearing formation when there is no pumping (L),
- h = height of the water level in the well above the water-bearing formation during pumping (L),
- R = radius of influence (L),
- r = radius of well (L).

The difference between H and h is the "drawdown" or drop in water in the well during pumping.

Equation 1 can be solved for hydraulic conductivity K:

$$K = \frac{q \log_e(R/r)}{2\pi b(H-h)} \qquad (2)$$

From a well log, the diameter of the well r and the thickness of the confined layer b can be determined. During pump testing, the drawdown (H - h) is measured as is the pumping rate q. The radius of influence R is the distance away from the well that drawdown can be detected. Equations 1 and 2 are not highly sensitive the radius of

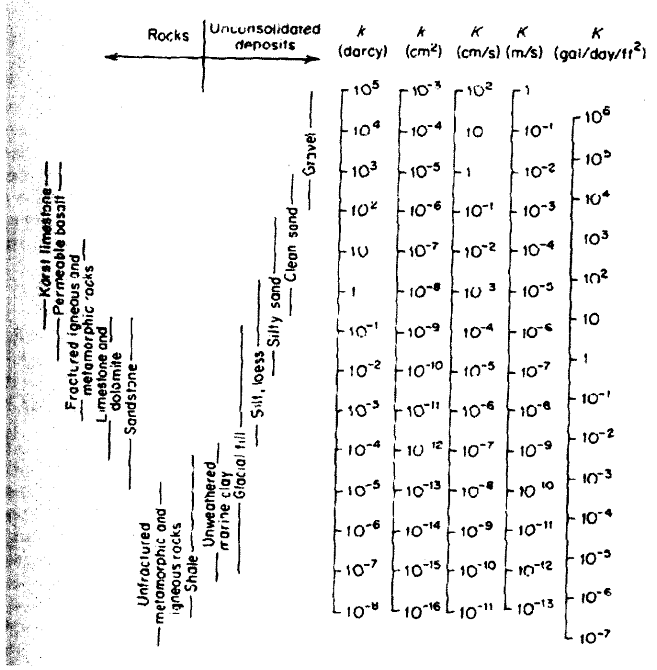

Figure 12. Range of values for hydraulic conductivity (Freeze and Cherry, 1979)

influence *R*, and so generally, a reasonable estimate is made (Schwab et al., 1993). In sedimentary formations, the suggested value for *R* is around 300 ft (Schwab et al., 1993). Table 4 presents the pump tests that were available from the well logs that were downloaded, and the hydraulic conductivity values predicted by equation 2 for those wells. The depth of aquifer yielding water, diameter of well, pumping rate, and drawdown were entered into equation 2 to calculate the hydraulic conductivity values.

Generally, there are wide ranges of observed values for hydraulic conductivity *K*. The values calculated in Table 4 are all well within observed values (Figure 12). Smoot (1987) estimated horizontal conductivity to be between 2×10^{-6} and 5×10^{-5} m/s, similar to the above values. For vertical conductivity, however, Smoot (1987) estimated the conductivity to be between 3.5×10^{-10} and 2.7×10^{-8} m/s, showing the high degree of anisotropy discussed previously. One observation of these hydraulic conductivity values is the relatively high value for granite and the relatively low value for sediment aquifers. In the context of wells, these values are strikingly similar. Also, the hydraulic conductivity of the sediments below the basalt (Moscow Well 514) is similar to the hydraulic conductivity of the sediments above the basalt (the Koster well). Because the hydraulic conductivity values are similar for all the materials in the area, the impacts of pumping on nearby wells will be the same whether the wells are in sediments or in granite. This will make further analysis less complex.

5.1.2 Estimating Impacts of Naylor's Pumping on Nearby Wells

One of the most common methods for estimating drawdown from nearby wells is the Theis method (Freeze and Cherry, 1979). This analysis allows the planner to estimate offsite impacts of pumping for different distances from a given well, and for different periods of time of pumping (hours to days to months).

There are a number of variations of this method, depending on the nature of the aquifer (unconfined, confined, leaky, with impermeable boundaries). For the Naylor site, with its myriad layers of aquifers of various materials (e.g. Naylor Exhibit 12) and high degree of anisotropy (Smoot, 1987), the best version of the Theis method is the "Leaky Aquifer" method (Freeze and Cherry, 1979). This method assumes that groundwater travels horizontally through aquifers, and vertically through layers with lower hydraulic conductivity values called aquitards. Table 4 provides good estimates for the horizontal hydraulic conductivity as most of the tests were of short duration, based on local information. A reasonable value for the Naylor site sediments, as well as the surrounding granitics, is about 1.0 x 10^{-4} ft/s (3 x 10^{-5} m/s). This value is midway between the basalt conductivities and the granite and sediment conductivities, and is similar to the value used by Smoot (1987) to model groundwater flow in the Moscow-Pullman region. In the absence of detailed information of the characteristics of the Naylor well (no pump test data were provided), this estimate will be sufficient to gain insight into the offsite impacts of the proposed pumping rate for the Naylor site.

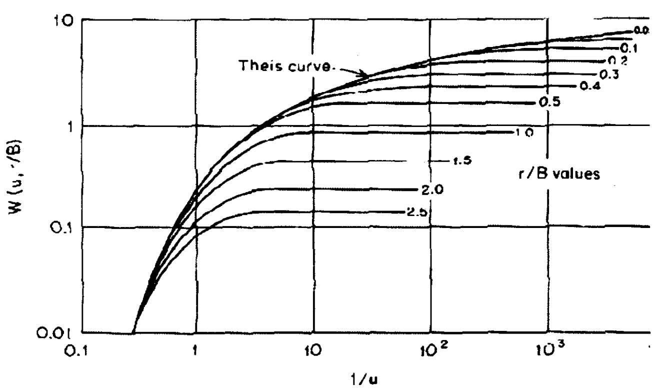

Figure 13. Theoretical curves of *W(u,r/b)* versus 1/*u* for a leaky aquifer (Freeze and Cherry, 1979)

For a leaky aquifer analysis, the Theis solution is (Freeze and Cherry, 1979)

$$H - h = \frac{q}{4\pi T} W(u, r/b) \tag{3}$$

where

H	=	height of the piezometric surface above the top of the water-bearing formation when there is no pumping (L),
h	=	height of the water level in the well, above the water bearing formation during pumping (L),
q	=	rate of abstraction (L^3/T),
T	=	hydraulic transmisivity of aquifer (L^2/T)
	=	$K\,b$
K	=	hydraulic conductivity (L/T)
b	=	thickness of the confined aquifer (L),
$W(u,r/b)$	=	well function for leaky aquifer (Figure 13)
u	=	$\frac{r^2 S}{4Tt}$
r	=	distance from well (L)
S	=	aquifer storativity (L/L)
T	=	time from the start of pumping (T)
r/b	=	$r\sqrt{\frac{K'}{K_1 b_1 b'}}$
K', K_1, b', b_1	=	conductivities and depth of aquitard and aquifer respectfully (L/T and L) (Figure 14)

The above equation can provide considerable insight in to the impacts of pumping at one well on nearby wells. Values must be assigned to each of the variables, and most of those values have already been determined. Table 5 defines each of the variables necessary to apply the Theis solution to wells in the vicinity of the Naylor site.

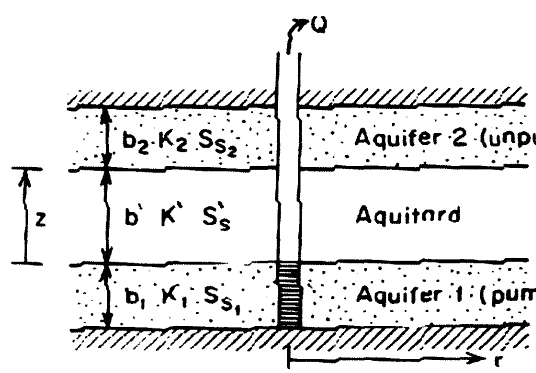

Figure 14. Schematic diagram of a two-aquifer "leaky" system (Freeze and Cherry, 1979)

Table 5. Values needed to apply the Theis solution to the Naylor site assuming a leaky aquifer.

Variable	Value	Source
$H-h$		Value to be determined
q	800 gal/min.	Less than what has been permitted, but probably a more reasonable maximum value
K_l	1 x 10^{-4} ft/s	Between Moscow 514 & Sunset wells
K'	1 x 10^{-6}	Below observed values, within range in Figure 13, but greater than Smoot (1987) for vertical *K*.
b_l	80 ft	From Naylor Test Hole and Moscow 514 well
b'	270 ft	Remainder of overburden above aquifer is aquitard top of aquifer is 380 ft deep, and water table is 30 ft deep (380-80-30) (IDWR 2004b)
S	0.01	Between a confined and an unconfined aquifer, Greater than Smoot (1987) estimate because of "Leaky" Assumption
r	Varied	Will assess for nearby wells
T	8 x 10^{-3} ft^2/s	K_l x b_l
t	120 days	Length of major irrigation pumping

The distances (*r*) to the 11 nearest wells (Figure 10) were measured using a Geographic Information System (GIS). These distances, the estimates of other values presented in Table 5, and the *W(u,r/b)* values determined from Figure 13 were used to estimate drawdown at each of the 11 wells. Table 6 presents the results of this analysis.

From Table 6, the first line estimates a drawdown of 170 feet by the Naylor well with the assumed pumping rate of 800 gal/min. This value is within the range of the drawdown values measured at the other two wells pumping from the sediment layers beneath the basalt (Table 4). **This shows that the water supply is insufficient to meet the 1800 gal/min pumping rate given in IDWR (2004) Order No. 8.**

It is also apparent that the pumping alone will be observed at all of the wells listed, including the Clark well, which is almost a mile away. These drawdowns are for the first year only, and do not take into account any depletion of water in the aquifer, and the general decline of water levels throughout the area (Ralston, 2004). That would lead to additional drops in the local wells. This analysis clearly demonstrates that nearby wells will be impacted by the proposed Naylor study with measurable drops in well levels the first season of abstraction. Thus **the IDWR (2004) Conclusions of Law Number 4 is not valid in that the Naylor pumping will reduce the quantity of water available at**

Table 6. Estimated drawdown at 11 wells nearest to Naylor site using the assumptions given in Table 4 and the distances from each respective well to the Naylor well site.

Well	r (m)	r (ft)	r/b	1/u	W(u)	Drawdown (ft)
At well		0.5	3.40E-04	9.58E+07	10	170.0
Townsend	554	1818	1.24E+00	7.25E+00	0.7	11.9
Wilder	592	1942	1.32E+00	6.35E+00	0.6	10.2
Darby	648	2126	1.45E+00	5.30E+00	0.5	8.5
Elliot	796	2612	1.78E+00	3.51E+00	0.4	6.8
Cameron	879	2884	1.96E+00	2.88E+00	0.3	5.1
Bizzeau 28	974	3196	2.17E+00	2.35E+00	0.2	3.4
Forbes	1035	3396	2.31E+00	2.08E+00	0.15	2.6
Gotsacker	1163	3816	2.60E+00	1.65E+00	0.12	2.0
Bizzeau 33	1252	4108	2.79E+00	1.42E+00	0.1	1.7
Willis	1433	4701	3.20E+00	1.08E+00	0.09	1.5
Clark	1444	4738	3.22E+00	1.07E+00	0.08	1.4

nearby wells even though there are aquitards separating the Naylor well from the nearby wells.

6. Experiences of Local Wells

Section 6 present a summary of concerns of local residents about their own groundwater resources.

An informal survey was carried out in the area to collect information about local experiences and concerns with domestic wells. Over 25 residents responded to the survey. Many of them had their well logs, or knew the details of their well. Of particular interest in the survey was information related to problems with low well yields, well failure, or poor water quality. Such information is generally not readily available. A summary of responses to those questions follows.

Q: Does the pump occasionally shut off because of low water in the well?

yes...we have a 2500 gallon holding tank and are very careful about how much we use.

no, but water slows down considerably after about 30 minutes if you draw more than 2.5 gpm. We have 2 - 40 gal pressure tanks.

yes

It did when we first moved into the house in 1988, but have installed a 1000 gallon reservoir as back up.

It will shut off if the water runs more than 15 minutes....Do not believe that it ever produced a great deal of water. Since it was only used at the barn there was not the intense pressure a home would put on it. Do not think I would put a home there without a big holding tank.

Occasionally pump will shut off if, in summer, we water too extensively.

Not since we increased the flow rate by hydrocracking.
(When we moved into the house (July, 1989) the rate was 4 gals/min. This slowly dropped to the point that it was less than 2 gals/min. We then employed a Spokane company who specialize in hydrocracking (about two years ago) and the rate was increased to 7 gals/min.)

No, we have a 2100 gallon storage tank and practice rigorous water conservation.

The pump will shut off if we forget to turn off a hose filling a water tank, or leave the single irrigation sprinkler running for more than about an hour.

Q: Have you had to redrill the well, or drill a new well? If so,when?

No, but hydrofractured the well in 1990.

NO, but we use water saving devices on all faucets/toilets and NEVER water the garden spaces around our house.

I believe they cleaned it out and added lining when the new pump was put into the well.

The original owners drilled one well that didn't work out and abandoned that one...this is the second well drilled that we use now.

We drilled at another site first and did not get water.

There are 3 capped wells on our 5 1/2 acres in addition to our working well.......3 wells had to be drilled before a good working well was drilled at the current location.

Two wells have been drilled on this property. The first was drilled in 1970, at that time: Depth: 448 feet, All Granite...GPM: 6. This well began to run dry and produce decomposed granite sediment. A new well was drilled in 2000. All granite, Depth: 710 ft... GPM: 2.5.

Yes, April '01 our 10 1/2 gpm well went dry. We then drilled our second well...

Q: Are you aware of well problems experienced by any of your neighbors?

YES, the owners of the house directly uphill from us redrilled a well about 7 or 8 years ago when their first well went dry.

Yes - (neighbors) - have had to dig a new well.

In the past a few individuals on West Twin Rd, closer to Moscow Mtn have had to punch their well down.

Neighbor up the hill,......., had to drill a new well last year.

know of several dry holes on the property next to Lot 9.

The former neighbor to the west of me indicated that her water pressure went down when our well went into production in 1988. I assume we are drawing from the same source.

yes, aware that some others nearby have low capacity wells too and have to conserve.

Across the road from us they use spring water and a cistern. The past 2 or 3 years they have had insufficient water and some of the springs dried up. They truck water in for the horses.

The adjacent lot on the other side of this lot has a well that draws 1/2 gpm after 2 wells were dug. Another well on a lot just kitty-corner from the divided lot also draws only 1.2 gpm again after 2 wells were dug.

Yes. My neighbor next door (we're on five acre parcels)......... had to drill another well.

I live on Moscow Mt on the West side of hwy 95 and all my neighbors have very low producing wells. some use sisterns to bank water for use at future times.

Neighbors just below us get 0.18 gallons per minute or less. They have water delivered twice a month.

Yes, the neighbor directly North of us experienced periodic water cut off during the '01 summer.

Also, (my neighbor) located 1/2 mile due west of us, had his well go dry in 2000. He also drilled a second well.

Our neighbor's well went dry the first year from watering our small lawn. He redrilled the well from 160 ft to 280 feet, and no longer does any lawn or garden watering. Like us, his water is high in iron and he has to treat it with a heavy duty water softener.

Q: Are there water quality problems?

--iron/rust.

No, unless we overdo usage and then there is some sediment - normally, there are only my husband and I in residence here, but when our grown children and their families come, we have a problem of sediment.

High levels of clay making the well unusable for drinking. I use it for occasional agricultural watering.

heavy calcium/ require softener to prevent mineral build-up.

About once a month the water comes out very cloudy for several days. The sediment is very fine and is not removed by a filter. We run the bathtub for a few days and ultimately the water clears up.

Iron removers at each house.

Hard water.

Our water is high in particulate and dissolved iron. Have installed an iron treatment system.

Additional Comments:

I have a 1000 gallon holding tank in the basement.... The well was originally rated at 1 1/2 gal per minute. It is a 3/4 horse pump....It has a Coyote on the well so it will only pump a short time. With the holding tank the pump does not work all that often but we are very careful with the water supply.

I've been told (my well is) 450 ft. deep & has a mediocre flow-rate at best.

The recharge rate of our well seems to have a direct but delayed correlation to the weather, i.e. during very wet years, we appear to get a greater rate of recharge some months later. The opposite is the case during very dry years, so we anticipate having much less water this year and are already implementing water saving measures such as fewer clothes & dish washing, and we ALWAYS take VERY short showers. We are located just a mile from the Naylor property and our well is deep enough that a draw-down from water below the Naylor property may well affect our water level due to reduced hydrostatic pressure in the granite water seams.

Really depend on my well out here.

6.1 Summary of Survey Results

These results show widespread problems and concerns about water quantity and quality by individual well owners about their own wells as well as concerns for their neighbors. Experiences of these residents confirm the findings of both the quantitative and qualitative analyses in this document. Many local residents have gone to considerable expense and inconvenience to maintain their tenuous water supplies. **With such validated concerns about limited water resources in the area, this survey alone**

justifies that a higher level of care needs to be exercised before granting any large water permits from limited local groundwater resources.

This survey also raises another very important attribute about the groundwater resources in the area, the water quality, and its suitability for trickle irrigation. Although beyond the scope of the testimony, the high iron and sediment contents of many of these wells indicate that this water cannot be used for trickle irrigation unless treatment systems are installed. The cost of installing and maintaining such systems may make the proposed project economically infeasible even if an adequate supply of water were available.

7. Conclusions

Section 7 summarizes the information presented, and draws conclusions about connectivity and availability of groundwater resources in the vicinity of the proposed Naylor test site.

This document has:

- Summarized the professional status of the author
- Reviewed the information related to geology in the Naylor water permit application
- Synthesized the information from over 160 well logs within 3 miles of the Naylor site and presented qualitative summaries
- Used the limited pump test data that were available to estimate aquifer hydraulic conductivity values, and to estimate drawdown at 11 wells within a mile of the Naylor site.
- Presented comments from local residents' experiences with their own groundwater resources.

Overall conclusions that can be drawn from the information presented in this document are:

- The Naylor proposal is extremely weak in science, and contains so many errors in analyses and data recording, that it is inadequate to support a request for a permit to abstract significant amounts of groundwater.
- Information in the Naylor proposal attempting to show a lack of connectivity is unsound and inadequate.
- There is no evidence in the well log data of a D street ridge.
- There are too many errors in the Naylor basin water balance to ascertain whether there will be sufficient recharge to offset the proposed water abstraction.
- With water levels generally declining already, it is apparent that local shallow (under 500 ft deep) groundwater resources are already over-subscribed.
- Analysis of the well logs clearly show that it is likely that the proposed Naylor pumping will impact neighboring wells whether pumping is from sediments below a basalt layer, from a basalt layer, or if there is no basalt layer.

- Analysis of the well logs predicted that wells as much as a mile will see a direct effect of the proposed Naylor water abstraction within months.
- It may be detrimental to even run the proposed test pumping protocol for several months because:
    - In the low conductivity aquifers in the Moscow basin, adverse impacts may be slow to be measured;
    - High rates of pumping could permanently compress the aquifer so it will never recharge to prepumping levels; and
    - Water currently required by existing well holders, both municipal and private, may be permanently lost.

The above conclusions can be summarized in terms of the issues that IDWR can consider (IDWR 2004a) , in a geologic context:

4a The appropriation will reduce the quantity of water under existing water rights.

4b The water supply itself is insufficient for the purpose for which it is sought to be appropriated.

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Appendix A. Selected Well Logs

Well A.1. Example of a domestic well in a basalt aquifer south of the Naylor site.

Form 238-7
6/90

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

USE TYPEWRITER OR BALLPOINT PEN

1. WELL OWNER

Name Esther Stalnaker
Address Moscow
Drilling Permit No. 87-91-N-9
Water Right Permit No. ______

2. NATURE OF WORK

☑ New well ☐ Deepened ☐ Replacement
☐ Well diameter increase
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☑ Rotary ☑ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☑ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.250 inches	8 inches	+ 1 feet	68 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☑ Yes ☐ No
Was a packer or seal used? ☐ Yes ☑ No
Perforated? ☐ Yes ☑ No
How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☑ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Gravel packed? ☐ Yes ☑ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 68 Material used in seal: ☐ Cement grout ☑ Bentonite ☐ Puddling clay ☐ ______
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☑ Overbore to seal depth
Method of joining casing: ☐ Threaded ☑ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W / E / S

Subdivision Name ______
Lot No. ______ Block No. ______
County ______
____ ¼ SW ¼ Sec. 5, T. 39 N ☑ S ☐ R. 5 E ☐ W ☑

7. WATER LEVEL

Static water level 92 feet below land surface.
Flowing? ☐ Yes ☑ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality ______
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
approx. 50	219'	30 min.

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	61	overburden		✓
8	61	91	basalt, firm		✓
8	91	95	basalt soft	✓	
8	95	222	basalt, firm		✓
8	222	229	fract. basalt	✓	

RECEIVED
SEP 06 1991
Department of Water Resources

10.

Work started 7/12/91 finished 7/15/91

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Witt Well Drilling Firm No. 58
Address 619 Powers Lew. Date ______
Signed by (Firm Official) Earl L. Witt
and
(Operator) Roger Witt

USE ADDITIONAL SHEETS IF NECESSARY — FORWARD THE WHITE COPY TO THE DEPARTMENT

Well A.2. City of Moscow well sealed in to the basalt.

ENT'D

RECEIVED
MAR 21 1956
Dept. of Reclamation

024836

WELL LOG AND REPORT TO THE
STATE RECLAMATION ENGINEER OF IDAHO

State of Idaho Ground Water Application No. G53842
State of Idaho Ground Water Permit No. G-25958

Log No. ____
Rec. ____, 19__
Well No. 87-56-N-1
Permit No. G-25958 LAPSED
87-2023
(DO NOT FILL IN)

Owner: City of Moscow, Idaho Address: c/o Harvey Smith, City Engineer, Moscow, Id.

Driller: A. A. DURAND & SON Address: P. O. Box 437, W. W., Wash. Lic. No. 47

Location of Well: SE ¼ NW ¼ Sec. 8, T. 39 N, R. 5 W, Latah County,

and ____ feet N/S, and ____ feet E/W from ____ Corner of ____ ¼ ____ ¼ Sec.

Size of Drilled Hole: 24" x 20" Total depth of Well: Drilled depth: 282' Plugged back well with gravel and concrete topping from 282' to 250'

Give depth of standing water from surface: 110' Water Temp.: 53 - 54° Farenheit

On pumping test 1/3-4/56 delivery was 1525 g.p.m. or ____ c.f.s. Drawdown was 80 feet.

Size of pump and motor used to make the test: Well driller's test pump; 2000 gpm with 225 hp. engine.

Length of time pumped during check was 27 hr., ____ minutes.

If flowing well, give flow in c.f.s. Artesian, non-flowing or g.p.m. ____ and shut in pressure ____

If flowing well, describe control works: none (TYPE AND SIZE OF VALVE, ETC.)

Water will be used for: city water supply Weight of casing per linear foot ____

Thickness of casing: 24" x 5/16" wall; 20" x 3/8" wall Casing material: standard black steel pipe (E.G., PIPE, CONCRETE, WOOD.)

Diameter, length and location of casing: See casing record below. (CASING 12" IN DIAMETER AND UNDER GIVE INSIDE DIAMETER; CASING OVER 12" IN DIAMETER GIVE OUTSIDE DIAMETER.)

Number and size of perforations: none located ____ feet to ____ feet from surface of ground.

Other perforations ____

Date of commencement of well: 10/20/55 Date of completion of well: 12/20/55 finished drilling; 1/4/56 finished final well test

Type of well rig: 36L Bucyrus Erie oil field spudder churn drill well drilling method

CASING RECORD

DIAM. CASING	FROM FEET	TO FEET	LENGTH	"REMARKS" -- SEALS, GROUTING, ETC.
28" O. D.	0	14	14	Conductor casing installed in beginning and pulled at job completion.
24" O. D.	0	69'7"	69' 7"	Casing seated on top of basalt; see note below
20" O. D.	0	126'	126'	Casing seated 56' into the basalt; see note below
20" O. D.	126'	282'	156'	Open hole drilling

WJE

GENERAL INFORMATION—Pumping Test, Quality of Water, Etc.

Note: Annular space between 24" and 20" between ground surface and 126' continuously grout sealed for sanitary and permanent protection. Chemical analysis of water from final well test made by state laboratories and city of Lewiston, Idaho lab. See attached field pump test record for well test data and chemical analysis from Lewiston lab. Drill cuttings sampled each 5' and retained in triplicate copies and distributed as follows:

1. U. S. Geological Survey at Boise, Idaho
2. Idaho Bureau of Mines and Geology, University of Idaho
3. A. A. Durand & Son, morgue file

SENW S.8 39N 5W

87

Well A.3. Two older Moscow Wells that were both sealed into the upper basalt layer as specified in IDWR (2004a) Conclusions of Law Number 4.

87-64-N-3

City of Moscow
Well No. 2 - Domestic
Drilled 1925 - A. A. Durand, Walla Walla, Washington

Total depth - 560 feet
Filled and concrete plug at 240 feet
20" casing seal in basalt at 40 feet
Remainder open

Original static	-	20 feet
Present static	-	100 feet
Drawdown	-	20 feet
Capacity	-	1200 GPM
Water Temp	-	54° F

87-64-N-4

City of Moscow
Well No. 3

Drilled 1926 - A. A. Durand, Walla Walla, Washington

Depth	-	261.5 feet
Concrete plug at	-	235 feet
Original Static	-	20 feet
Present Static	-	100 feet
Drawdown	-	20 feet
Capacity	-	1400 GPM
Water Temp	-	54° F

18" casing in basalt at 40 feet
Remainder open

87 NE NW S.8 39N 5W

Well A.4. Moscow Well from T39N, R5W, Section 8. Drilled through basalt to the sediments below for a total depth of 250 ft.

ENT'D

RECEIVED
MAR 21 1956
Bureau of Reclamation

024836

WELL LOG AND REPORT TO THE
STATE RECLAMATION ENGINEER OF IDAHO

State of Idaho Ground Water Application No. G33842
State of Idaho Ground Water Permit No. G-25958

Log No. ______
Rec. ______, 19__
Well No. 87-56-N-1
Permit No. G-25958 LAPSED
87-2023
(DO NOT FILL IN)

Owner: City of Moscow, Idaho Address: c/o Harvey Smith, City Engineer, Moscow, Id.

Driller: A. A. DURAND & SON Address: P. O. Box 437, Walla Walla, Wash. Lic. No. 47

Location of Well: SE ¼ NW ¼ Sec. 8, T. 39 N/S, R. 5 E/W, Latah County,

and ______ feet N/S, and ______ feet E/W from ______ Corner of ______ ¼ ______ ¼ Sec.

Size of Drilled Hole: 24" x 20" Total depth of Well: Drilled depth: 282' Plugged back well with gravel and concrete topping from 282' to 250'

Give depth of standing water from surface: 110' Water Temp.: 55 - 54° Farenheit

On pumping test/delivery was (1/3-4/56) 1586 g.p.m. or ______ c.f.s. Drawdown was 80 feet.

Size of pump and motor used to make the test: Well driller's test pump; 2000 gpm with 225 hp. engine.

Length of time pumped during check was 27 hr., ______ minutes.

If flowing well, give flow in c.f.s. Artesian, non-flowing or g.p.m. ______ and shut in pressure ______

If flowing well, describe control works: none
(TYPE AND SIZE OF VALVE, ETC.)

Water will be used for: city water supply Weight of casing per linear foot: ______

Thickness of casing: 24" x 5/16" wall; 20" x 3/8" wall Casing material: standard black steel pipe
E.G., PIPE, CONCRETE, WOOD.

Diameter, length and location of casing: See casing record below.
(CASING 12" IN DIAMETER AND UNDER GIVE INSIDE DIAMETER; CASING OVER 12" IN DIAMETER GIVE OUTSIDE DIAMETER.)

Number and size of perforations: none located ______ feet to ______ feet from surface of ground.

Other perforations ______

Date of commencement of well: 10/20/55 Date of completion of well: 12/20/55 finished drilling; 1/4/56 finished final well test

Type of well rig: 36L Bucyrus Erie oil field spudder churn drill well drilling method

CASING RECORD

DIAM. CASING	FROM FEET	TO FEET	LENGTH	"REMARKS" -- SEALS, GROUTING, ETC.
28" O. D.	0	14	14	Conductor casing installed in beginning and pulled at job completion.
24" O. D.	0	69'7"	69' 7"	Casing seated on top of basalt; see note below
20" O. D.	0	126'	126'	Casing seated 56' into the basalt; see note below
20" O. D.	126'	282'	156'	Open hole drilling

WAH.

GENERAL INFORMATION—Pumping Test, Quality of Water, Etc.

Note: Annular space between 24" and 20" between ground surface and 126' continuously grout sealed for sanitary and permanent protection. Chemical analysis of water from final well test made by state laboratories and city of Lewiston, Idaho lab. See attached field pump test record for well test data and chemical analysis from Lewiston lab. Drill cuttings sampled each 5' and retained in triplicate copies and distributed as follows:

1. U. S. Geological Survey at Boise, Idaho
2. Idaho Bureau of Mines and Geology, University of Idaho
3. A. A. Durand & Son, morgue file

SENW S.8 39N 5W

87

Well A.5. Moscow well from T39N R5W, Section 17, drilled through basalt in to the underlying sediments.

RECEIVED
Form 238-7 SCANNED
MAY 0 9 1997
NORTHERN REGION

IDAHO DEPARTMENT OF WATER RESOURCES

WELL DRILLER'S REPORT

Use Typewriter or Ballpoint Pen

96190

Office Use Only
Inspected by ____
Twp ____ Rge ____ Sec ____
____ 1/4 ____ 1/4 ____ 1/4
Lat: : : Long: : :

1. DRILLING PERMIT NO. 87-96-N-0002-000
Other IDWR No. 87-07193

2. OWNER:
Name CITY OF MOSCOW
Address P.O. BOX 9203
City Moscow State ID. Zip 83843

3. LOCATION OF WELL by legal description:
Sketch map location must agree with written location.

Twp. 39 North [X] or South [ ]
Rge. 05 East [ ] or West [X]
Sec. 17, ____ 1/4 NE 1/4 SE 1/4
Gov't Lot ____ County LATAH
Lat: : : Long: : :
Address of Well Site 1423 SOUTH MOUNTAIN VIEW RD. City MOSCOW ID.
(Give at least name of road + Distance to Road or Landmark)
Lt. ____ Blk. ____ Sub. Name ____

4. USE:
[ ] Domestic [X] Municipal [ ] Monitor [ ] Irrigation
[ ] Thermal [ ] Injection [ ] Other ____

5. TYPE OF WORK check all that apply (Replacement etc.)
[X] New Well [ ] Modify [ ] Abandonment [ ] Other ____

6. DRILL METHOD
[X] Air Rotary [X] Cable [ ] Mud Rotary [ ] Other ____

7. SEALING PROCEDURES

Seal/Filter Pack Material	From	To	Amount (Sacks or Pounds)	Method
NEAT CEMENT	0	100	243 SKS	PRESSURE GROUTED FROM BOTTOM
FILTER SAND SIZE 10/30	406	508	88 SKS	TREMIED

Was drive shoe used? [X] Y [ ] N Shoe Depth(s) 100 FT + 449
Was drive shoe seal tested? [X] Y [ ] N How? WATER PRESSURE

8. CASING/LINER:

Diameter	From	To	Gauge	Material	Casing	Liner	Welded	Threaded
20"	+1	100	375	STEEL	[X]	[ ]	[X]	[ ]
16"	+2	449	375	STEEL	[X]	[ ]	[X]	[ ]
10	407	437	365	STEEL	[ ]	[X]	[X]	[ ]

Length of Headpipe 30' Length of Tailpipe 0

9. PERFORATIONS/SCREENS
[X] Perforations Method MILLS KNIFE
[X] Screens Screen Type PIPE SIZE

From	To	Slot Size	Number	Diameter	Material	Casing	Liner
260	270	6X4	80	16"	STEEL	[X]	[ ]
						[ ]	[ ]
437	508	#30		10	STAINLESS	[ ]	[X]

10. STATIC WATER LEVEL OR ARTESIAN PRESSURE:
129 ft. below ground Artesian pressure ____ lb.
Depth flow encountered 265 ft. Describe access port or control devices: 2" PIPE WITH 2" SCREWED CAP

11. WELL TESTS:
[X] Pump [ ] Bailer [ ] Air [ ] Flowing Artesian

Yield gal./min.	Drawdown	Pumping Level	Time
100	83	212	1 HR
125	214	343	3 HR

Water Temp. 57° Bottom hole temp. 57°
Water Quality test or comments: VERY POOR PRODUCER
32 FT Depth first Water Encountered

12. LITHOLOGIC LOG: (Describe repairs or abandonment)

Bore Dia.	From	To	Remarks: Lithology, Water Quality & Temperature	Water Y	Water N
26	0	3	TOP SOIL		X
26	3	32	CLAY BRN		X
26	32	60	GRAVEL + CLAY	X	
26	60	94	CLAY BRN		X
26	94	100	BASALT BLK		X
19	100	260	BASALT GREY		X
19	260	273	BASALT BLK FRACTURED	X	
19	273	347	CLAY, SANDY GRN		X
19	347	410	CLAY, SANDY BRN		X
19	410	420	CLAY BLU		X
19	420	444	CLAY BRN		X
19	444	508	GRANITE SAND FINE	X	
19	508	514	CLAY BRN		X
			HOLE WAS BACKFILLED FROM 508 TO 514		
			GRANITE SAND HARD + CONSOLIDATED		
			CEMENT SEAL PLACED AT TOP OF SCREEN ASSEMBLY (408 TO 410)		

Completed Depth 508 (Measurable)
Date: Started June 6-96 Completed March 10-97

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name HOLMAN DRILLING CORP Firm No. 108
Firm Official [signature] Date April 9-97
and
Supervisor or Operator [signature] Date ____
(Sign once if Firm Official & Operator)

NESE 17 39N 5W

FORWARD WHITE COPY TO WATER RESOURCES

Well A.6. Example of a private well drilled through the upper basalt layer accessing the sediments below.

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

WELL DRILLER'S REPORT

RECEIVED OCT 20 1988 Department of Water Resources

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Jerry Schutz
Address Moscow
Owner's Permit No. 87-88-N-20-400

2. NATURE OF WORK

☐ New well ☐ Deepened ☑ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☑ Rotary ☑ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☑ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.264 inches	8 inches	+ 1 feet	99 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☑ Yes ☐ No
Was a packer or seal used? ☐ Yes ☑ No
Perforated? ☐ Yes ☑ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☑ No
Manufacturer's name
Type ______ Model No.
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☑ No ☐ Size of gravel
Placed from ___ feet to ___ feet
Surface seal depth 99 Material used in seal: ☐ Cement grout ☐ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☑ Overbore to seal depth
Method of joining casing: ☐ Threaded ☑ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W / E / S

Subdivision Name
Lot No. ____ Block No. ____
County Latah
NE ¼ NE ¼ Sec. 5, T. 39 N/S, R. 5 E/W.

7. WATER LEVEL

Static water level 102 feet below land surface.
Flowing? ☐ Yes ☐ No G.P.M. flow
Artesian closed-in pressure ____ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
approx. 100+		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
12	0	98	[illegible], clay		✓
8	98	281	[illegible]		✓
8	281	282	[illegible]		✓
8	282	303	gray [illegible] + clay		✓
8	303	304	sand	✓	

RECEIVED SEP 2? 1988 Department of Water Resources Northern District Office

10. Work started 8/30/88 finished 9/5/88

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name [illegible] Firm No. 58
Address 219 [illegible] Date 9/17/88
Signed by (Firm Official) Earl L. Witt
and (Operator) Roger Witt

USE ADDITIONAL SHEETS IF NECESSARY — FORWARD THE WHITE COPY TO THE DEPARTMENT

Well A.7. Moscow Well Number 6 originally drilled in to basalt, and when it went dry within two years, redrilled into a deeper basalt layer.

87-30028
87-56N-1-1

APR 29 1964
Department of Reclamation

City of Moscow, Idaho
Well No. 6 - Domestic
SE NW 8 39N 5W
Drilled originally in 1955 - Driller - A.A. Durand and Son
Walla Walla, Washington

Depth	- 280 feet
Static	- 110 Feet
Capacity	- 1200 GPM
Drawdown	- 20 feet
Temp	- 54° F

Well went dry in December, 1957

Started present well February, 1958
Complete May, 1960 Driller - Oliver Zinkgraf

Depth	- 1305 feet
Static	- 275 feet
Drawdown	- 25 feet
Capacity	- 1150 GPM
Water Temp	- 72° F

14 inch casing from surface, sealed in basalt at 905 feet
10 inch perforated liner - 1095 - 1305

usgs

SE NW 8
~~NESE~~ S.7 39N 5W

87

Well A.8. Irrigation well for Sunset Memorial Gardens Cemetery, Mountain View Road, Moscow.

(ENT'D)

WELL LOG AND REPORT TO THE
STATE RECLAMATION ENGINEER OF IDAHO

024832

A. A. DURAND & SON
Well Drilling Contractors
P. O. Box 437
Walla Walla, Washington

Log No. ______
Rec. ______, 19____
Well No. 87-55-N-1
Permit No. ______
(DO NOT FILL IN)

Owner: SUNSET MEMORIAL GARDENS, INC. Address: Moscow, Idaho

Driller: A. A. DURAND & SON Address: Walla Walla, Wash. Lic. No. 47

Location of Well: NE ¼ SE ¼ Sec. 17, T. 39 N, R. 5 W B/M Latah County,

and ______ feet N/S, and ______ feet E/W from ______ Corner of ______ ¼ ______ ¼ Sec.

Size of Drilled Hole: 12" x 10" x 8" Total depth of Well: 508'

Give depth of standing water from surface: 124' Water Temp. 57° - 59 °Farenheit

On pumping test delivery was 650 g.p.m. or ______ c.f.s. Drawdown was 64 feet.

Size of pump and motor used to make the test: 100 hp. diesel engine with vertical belt pulley drive. 252' of 6" pump column with 15 stage, 8" bowls; airline installed inside of pump column.

Length of time pumped during check was 24 hrs. continuously hr., ______ minutes.

If flowing well, give flow in c.f.s. ______ or g.p.m. ______ and shut in pressure ______

If flowing well, describe control works ______ (TYPE AND SIZE OF VALVE, ETC.)

Water will be used for: Irrigation of cemetery Weight of casing per linear feet: 12" - 45½ lbs. 8" - 25.5 lbs.

Thickness of casing: 8 5/8" O.D. x 8" I.D. 12 3/4" O.D. x 12" I.D. Casing material: Standard black steel pipe (E.G., PIPE, CONCRETE, WOOD.)

Diameter, length and location of casing: Pump pit 7' below ground surface.
(CASING 12" IN DIAMETER AND UNDER GIVE INSIDE DIAMETER; CASING OVER 12" IN DIAMETER GIVE OUTSIDE DIAMETER.)

Number and size of perforations: none located — feet to — feet from surface of ground.

Other perforations: See well screen data in casing record

Date of commencement of well: May 17, 1955 Date of completion of well: August 23, 1955

Type of well rig: 82 Speed star - spudder - cable tool

Well drilled under supervision of Consulting Engineer Frank S. Junk, Moscow, Idaho

CASING RECORD

All measurements are based on ground surface. 8' depth of dug well pit. 6

DIAM. CASING	FROM FEET	TO FEET	LENGTH	"REMARKS" -- SEALS, GROUTING, ETC.
12" I.D.	6' 11"	91' 8"	84' 9"	12" seated into top of first basalt drilled through 18' of natural clay seal material forming an effective seal against "surface water" infiltration into well
* 8" I.D.	6' 11"	461'	454' 1"	8" casing seated within aquifer sand - pulled back to expose screen.
6 5/8" I. D. x 7½" O.D.	455' 10"	508'	52' 2"	8" telescope type Johnson, Everdur well screen with No. 25 slot. Bottom of well screen is completed depth of well filled back from 582' for screen foundation.

GENERAL INFORMATION—Pumping Test, Quality of Water, Etc.

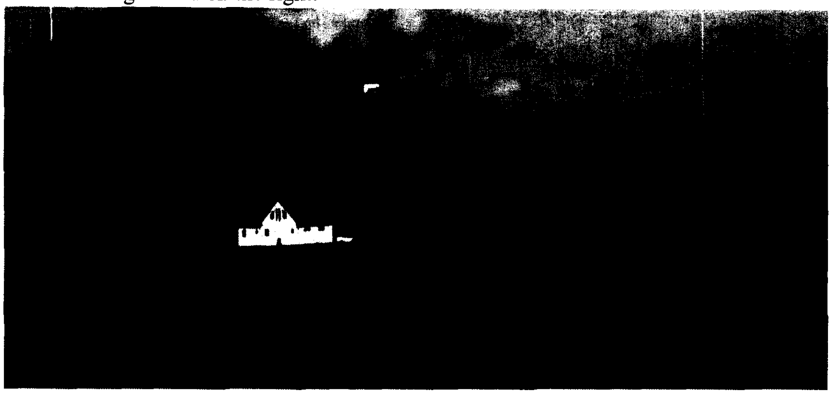
*Note: 8" casing anchored to 12" casing with casing cap installed 8/23/55 to prevent 8" (hanging free) from slipping down over screen.

Water supply developed in interbasalt sediments within a thick aquifer sand.

NESE S.17 39N 5EW

87

Well A.9 Two newly drilled wells immediately to the East of the Naylor site. The Townsend well is for the new house on the lower left of the photo, and the other "New Well" is being drilled on the right.



According the Clint Townsend, his well is 220 ft deep, through 220 ft of overburden, and then obtaining water from an aquifer of quartz and granite chippings. The static water level is 205 ft (Personal communication with Clint Townsend Feb. 9,2005). The well yield is 6 gal/min (Personal communication with Debbie Loiza, Feb. 9, 2005)

The new well on the left is 430 ft deep, with steel casing for 100 ft, through sediments, and the remainder of the depth into granite. The well yield is 60 to 70 gals/min. (Personal communication with Dr. George Grader, Feb. 22, 2005)

9. Appendix B. Summary of all Well Logs Considered

The units on depth are feet.
Static is the distance in feet from the top of the well to the static water surface.
Discharge is the pumping rate noted on the well log in gallons/minute.
Use is domestic unless otherwise noted.
Owner is the well owner's name that was occasionally noted to aid with further analysis.
Redrill indicates whether the well was an existing well that was redrilled, or an additional well drilled by the same owner on the same site

B.1. Wells in basalt

Township	Section	Quarter	Depth	Static	Discharge	Drawdown	Use	Owner	Redrill
T39N R5W	3	NW SW	197	148	7				
T39N R5W	4	NE NW	203	158	40				
T39N R5W	4	NE NW	207	135	4				
T39N R5W	4	SE NW	235		30				
T39N R5W	4	NE NE	353	145	20				
T39N R5W	4	SW SW	220	175	12	7			
T39N R5W	4	SW SW	170	69	2				
T39N R5W	4	SE SW	188	140	15				Redrill
T39N R5W	4	SE SE	189	119	18				
T39N R5W	4	NE SE	180	115	200				
T39N R5W	4	NE SE	170	125	16				
T39N R5W	5	NE NW	245	170	15				Redrill
T39N R5W	5	NW NW	169	97	15				
T39N R5W	5	NW NE	164	110	15				
T39N R5W	5	SW NW	190	105	50				
T39N R5W	5	NE NE	228	154	20				
T39N R5W	5	N NE	228	190	40				
T39N R5W	5	SE NE	278	210	45				
T39N R5W	5	SW NE	275	135	20				
T39N R5W	5	NW SE	250	200	20				
T39N R5W	5	NE SE	189	138	30				
T39N R5W	5	NE SE	179	135	75				
T39N R5W	5	SE SE	250	205	30				
T39N R5W	5	SE SE	225	164	30				
T39N R5W	5	N SW	203	170	50				
T39N R5W	5	N SW	229	92	50				
T39N R5W	5	NW SW	165	145	25				
T39N R5W	6	SE SW	208	150	15				
T39N R5W	6	SE SE	230	117	6				
T39N R5W	6	SE SE	153	128	5				
T39N R5W	6	SE SE	279	128	25				Redrill
T39N R5W	8	NE NE	148	30	10				
T39N R5W	8	NE NW	180	90	3				
T40N R5W	28	SW SE	175	38	20				
T40N R5W	31	NE NE	330	212	30				
T40N R5W	31	SW SE	128	70	15				
T40N R5W	31	SE SW	280	54	25				
T40N R5W	33	NE NE	160	80	35				
T40N R5W	33	NW NE	173	68	12			Bizzeau	4th Well
T40N R5W	33	SW NW	92	14	25				
T40N R5W	33	NW SE	155	38	12			Wallace	3rd Well
T40N R5W	33	NE SW	184	153	15				
Average			206.0	124.9	27.3				
T39N R5W	8	NE NW	240	20	1200	20	Muni	Moscow	
T39N R5W	8	NE NW	261	100	1400	20	Muni	Moscow	
T39N R5W	8	SE NW	280	110	1200	110	Muni	Moscow	Went Dry
Average			260	77	1267				

B.2. Wells in decomposed granite (DG)

Township	Section	Quarter	Depth	Static	Discharge	Drawdown	Owner	Redrill
T39N R5W	3	NE NW	140	20	8	30		
T39N R5W	4	SW NE	239	None				
T39N R5W	5	NE NW	64	22	10			
T39N R5W	5	NE NW	80	29	14			Redrill
T39N R5W	5	NW NW	280	84	50			
T39N R5W	5	SW NW	127	83	8			
T40N R5W	4	NE NE	229	80	8			
T40N R5W	4	NE NE	184	73	3.5			
T40N R5W	4	NE NW	84	10	5			
T40N R5W	4	SE NE	310	70	5	30		
T40N R5W	4	SE NE	130	28	7			
T40N R5W	4	N SE	92	65	0.5	57		
T40N R5W	4	N SE	86	18	7	50		
T40N R5W	4	SE SE	305	0.25				
T40N R5W	4	NW SW	124	2				
T40N R5W	4	NW SW	261	1.5				
T40N R5W	16	SW NW	225	11	15			
T40N R5W	17	NW NE	91	20	4			
T40N R5W	19	SW NW	325	17	25		Fairchild	
T40N R5W	20	SW NW	325	17	25		Bell	
T40N R5W	20	SW NW	250	110	6			
T40N R5W	21	NE NE	500	72	0.5			
T40N R5W	22	SE SW	150	103	1.5			
T40N R5W	22	SW SW	200	21	3			
T40N R5W	26	NE SE	370	5	0.5			
T40N R5W	27	NW NW	150	26	7			
T40N R5W	27	NE SW	96	4	2			
T40N R5W	27	SW SW	205	25	1.5			
T40N R5W	27	SW SW	455	80	3			
T40N R5W	28	SW SE	275	21	1			
T40N R5W	29	NW NW	422	160	30			
T40N R5W	29	NE NE	284	75	12		Adamski	Redrill
T40N R5W	32	SW SW	118	73	3			
T40N R5W	33	NW SE	78	14	4		Wallace	
T40N R5W	33	NW SE	79	16	5		Wallace	2nd Well
T40N R5W	35	SW NW	191	92	0.5		Preece	2nd Well
Average			206.9	43.3	8.5			

B.3. Wells in granite

Township	Section	Quarter	Depth	Static	Discharge	Owner	Redrill
T40N R5W	4	NW NW	267	20	4		
T40N R5W	4	SW NW	284	50	0.5		
T40N R5W	4	SE NW	103	19	5		
T40N R5W	8	SW SE	350	10	30		
T40N R5W	16	NW NW	554				
T40N R5W	17	NW NE	370	150	50		
T40N R5W	17	NW NE	606	270	0.25		
T40N R5W	17	NW NE	195	149	1.5		
T40N R5W	17	SW NE	254	93	2		
T40N R5W	17	SW NE	370	220	0.33		
T40N R5W	17	SW NE	507	215	3		
T40N R5W	17	SE NE	252	120	1.25		
T40N R5W	17	NE NW	304	75	0.5		
T40N R5W	17	SE NW	200	30	6		2nd Well
T40N R5W	19	NE NE	110	3	20		
T40N R5W	19	NE NE	310	50	2		
T40N R5W	19	SW NE	305	17	20		
T40N R5W	21	NE NE	325	72	8		
T40N R5W	21	SE NE	155	19	6	Connolly	
T40N R5W	21	SE NE	305	39	1	Connolly	2nd Well
T40N R5W	21	SE NE	139	80	9.5		
T40N R5W	21	SW NW	305	52	5		
T40N R5W	21	SW NW	353	98	1		
T40N R5W	21	NW SW	385		0.5	Garton	
T40N R5W	21	NW SW	450		0	Garton	2nd Well
T40N R5W	21	NW SW	270	32	50	Garton	3rd Well
T40N R5W	21	NW SW	278	28	11		
T40N R5W	26	NE NE	243	10	15		
T40N R5W	27	NW NW	127	62	2		
T40N R5W	27	NE SW	129	51	3		
T40N R5W	27	NW SW	300	9	10		
T40N R5W	27	SE SW	255	31	10		
T40N R5W	27	SW SW	99	5	3.5		
T40N R5W	28	NW NE	350	147	6		
T40N R5W	28	NW NW	425	150	20		
T40N R5W	28	NE NE	500	19	4		
T40N R5W	31	SW SE	225	20	10		
T40N R5W	35	SW NE	502	92	1		
T39N R5W	3	NW SW	173	141	15		
Average			298.3	73.6	8.9		

B.4. Wells in sediments

Township	Section	Quarter	Depth	Static	Discharge	Owner	Redrill
T39N R5W	4	SE SW	40	16	6		
T39N R5W	4	NW SW	95	61	2		
T39N R5W	4	SE SW	85	42	20		
T39N R5W	5	NW SE	150	90	2		
T40N R5W	28	NE NW	100	25	5		
T40N R5W	35	NE NE	120		0		
T39N R5W	5	SW NW	125	26	12		
T39N R5W	6	NE NE	108	68	10		
T39N R5W	6	NE NE	110	83	10		
T39N R5W	5	NE NW	131	63	5		
T39N R5W	5	SE NW	104	78	15		
T39N R5W	6	NE NE	62	26	12		
T40N R5W	34	SW SE	84	35	2		
T40N R5W	35	NE NE	185	27	3		
Average			118.9	51.1	7.7		

B.5. Wells in quartz

Township	Section	Quarter	Depth	Static	Discharge	Owner	Redrill
T39N R5W	6	NE NE	116	62	3		Redrill
T39N R5W	3	NW NW	78	40	15		
T39N R5W	6	N SE	65	35	30		
T40N R5W	28	NW SE	220	205	5		
T40N R5W	29	NE NE	166	75	20	Adamski	
T40N R5W	29	NE NE	238	80	20		
T40N R5W	34	NW NW	140	20	5	Gibb	
T40N R5W	34	NW NW	345	134	4	Gibb	Deepened
T40N R5W	35	SW NW	253	75	6	Preece	
Average			180.1	80.7	12.0		

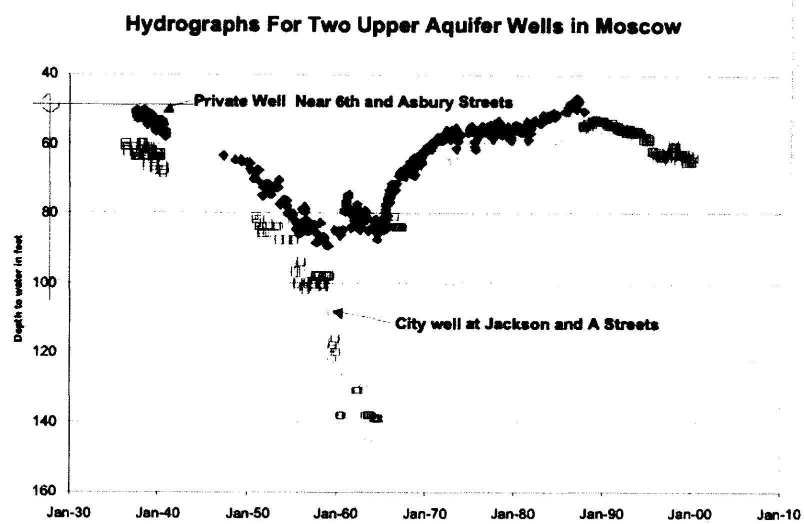
B.6. Wells in sediments below the first basalt layer

Township	Section	Quarter	Depth	Static	Discharge	Drawdown	Use	Owner	Redrill
T40N R5W	31	NW NW	235	30	13				
T40N R5W	33	NW NE	354		0			Bizzeau	
T40N R5W	33	NW NE	293	50	1			Bizzeau	2nd Well
T40N R5W	33	NW NE	153	123	10			Bizzeau	3rd Well
T39N R5W	5	NE NE	304	102	100			Schutz	
T39N R5W	5	SW NW	416	205	100			Qualls	
T39N R5W	5	SE NW	405	210	14	0		Marineau	
T39N R5W	17	NE SW	208	84	0.5				
T39N R5W	17	SE SW	300	85	4				
T39N R5W	17	NE SE	508	124	650	54	Irrigation	Sunset Mem.	
T40N R6W	25	SE NE	324	95	7.5				
T40N R5W	31	NW NW	350	233	55				
T40N R5W	31	NW NW	350	146	60				
T40N R5W	31	NW NW	375	142	65				
T40N R5W	31	NW NW	372	108	100				
T40N R5W	31	SW NW	400	171	100				
T40N R5W	31	S SW	331	150	100				
T40N R5W	31	SW SW	160	90	15				
Average			324	126	78				
T39N R5W	8	SE NW	250	110	1585	80	Muni	Moscow	
T39N R5W	17	NE SE	508	124	650	54	Muni	Moscow	
T39N R5W	8	SE NW	300	69			Cathodic		

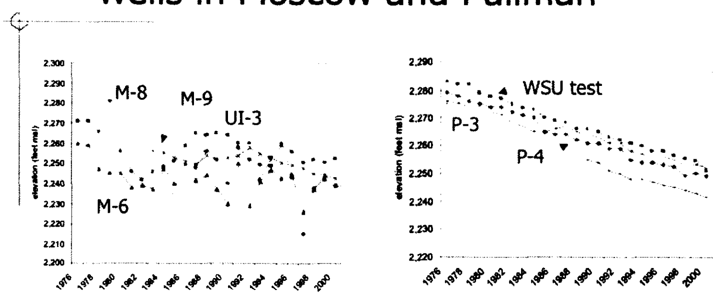
B.7. Wells in second basalt layer

Township	Section	Quarter	Depth	Static	Discharge	Drawdown	Use	Owner	Redrill
T39N R5W	8	SE NW	1305	275	1150	25	Muni	Moscow	Redrill

Appendix C. Long term hydrographs for shallow and deep aquifers in area (Ralston, 2004)



Water Levels from Grande Ronde wells in Moscow and Pullman



Moscow Wells **Pullman Wells**

Elliot, 3281 Foothill Road, Moscow, ID 83843
208 883 4494 elliot@mosow.com

October 25th, 2006

Latah County Zoning Commission
Latah County Courthouse
522 South Adams
Moscow, ID 83843

Dear Sirs:

Proposed Rezone of 36 of 135 acres at the intersection of Lewis and Foothill Roads

It has come to my attention that Bennett Realty, on behalf of their client, has requested a rezone of 36 acres within a 135 acre parcel north of the intersection of Foothill and Lewis Roads. I am opposed to this rezone. My main concern is that the water in this area may not be adequate to support this level of housing density.

1. I am a registered professional engineer, and have studied the well yields in this area in some detail in preparation for the Naylor Water Rights Application in 2005.
2. I have checked the yields of 21 wells in the area of the proposed zoning change, in Sections 17 to the north and 21 to the south of the site. The IDWR records show that of these 21 wells, one was dry, 5 yielded less than 1 gal/min, 7 were between 1.5 and 5 gal/min, 4 were between 6 and 10 gal/min, and only 4 yielded more than ten gal/min.
3. Four of the 21 owners had to drill two wells in this area, and one owner drilled 3 wells before getting an acceptable yield.
4. The well logs record that all of these wells were in granite. In granite, water is stored in fissures and cracks, and not in the mass of rock. Therefore, the chances of drilling into a fissure or crack is low, as demonstrated by the above distribution of well yields. Also, if a well does intersect a crack that was already tapped into by a previous owner, there is a high likelihood that the new well could dewater the previous one, particularly if it is downhill. The proposed rezoning is in fact, downhill from many of the 21 wells noted in point 2. Prior to this application, I have heard from two property owners in this area that they have had such an experience when a new well was drilled downhill from their well. There are likely others who have had similar experiences.

I am not opposed to all rezoning requests to allow additional rural residences. In this case, however, with a large number of existing wells immediately uphill from the proposed rezoning site, and with all wells in granite, I believe it is technically unwise to start such dense housing development in the absence of any plans for a community water supply. Therefore, unless the developers can provide sound evidence of an adequate water source, not in granite, to support such a development, it must be rejected as it will adversely impact water resources, and the value of existing properties.

Sincerely

William J. Elliot, PE, PhD

April 15, 2008

To: Latah County Planning Commission
From: Wayne A. Fox waf@moscow.com
Re: Input on Comprehensive Plan: Land Use, Water Resources Elements

cc: PWCN, Sid Eder

Dear Commission Members:

During your pre-workshop meeting on April 8, 2008, Karl Stocek discussed the importance of considering long-range continental and global trends while the commission in the process of updating the comprehensive plan. He noted several issues related to agriculture. Later in the "work shop" Sid Eder, made what is a very important, but often overlooked point – farming on the Palouse is basically dry farming with very little use of our limited water resources for irrigation.

Appended below are two articles from *New Scientist* which bear upon this issue. The first article says the world is basically running out of arable land; in the near future there may not be enough arable land to produce sufficient food for the world's population. The second article discusses the related issue of the impact of a wheat disease in Asia.

Why are you being sent these articles?

Because the issue of food production, worldwide food requirements, water resources, and preserving arable land, including land which is now only marginally arable, should loom large in your thinking about the land use and water resource elements in the comprehensive plan.

As several participants in the April 8th meeting pointed out, once open space, which includes arable and marginally arable, is developed, there is no getting it back. The same is true of water -- once severely depleted or contaminated, it is basically gone for a very long time. Preserving farmland not only makes good economic sense and has many other values, but is a way Latah County can contribute in a positive way to the entire world's population. The same kind of argument can be made for preserving timberland and wooded areas.

Perhaps you do not need reminding, but never-the-less please permit me to remind you anyway. The purpose of a comprehensive plan is to serve the long range interests of the entire county. It is not to provide opportunities for real estate agents nor is it to define land use solely so that developers can have material to work with.

On another subject: The mayor of Genesee took exception to some statements I made about the water in the Genesee area at the April 8th meeting. He called me the next morning. We had an amiable discussion during which he noted that water from one of the City of Genesee's wells had not been potable for eight years due to nitrate contamination. He denied that dry cleaning solvents were ever a problem in the area. His version of the entire Genesee area ground water differs from that of my memory. Sometime in the next month, I will gather material and forward it to you on the subject. I do this in part because commission member Bob Henriksen raised the issue of groundwater contamination by agricultural chemicals. It is important for the commission to have what facts are available on this matter concerning water on the Palouse.

Thank you for your consideration.

/s/ Wayne A. Fox

Wayne A. Fox
1009 Karen Lane
P.O. Box 9421
Moscow, ID 83843

(208) 882-7975
waf@moscow.com

World's poor are up in arms over food prices

- 26 January 2008
- NewScientist.com news service
- Debora MacKenzie

"We apologise for recent price increases," reads the sign over the bread counter, "but they are due to global factors beyond our control." This is not a Third World food stall but an upscale supermarket in Brussels, capital of the European Union, whose farming system was once notorious for the mountains of surplus grain it produced.

Those mountains are now gone. The world is down to its lowest grain stocks for decades, and food prices are up around the world.

There were street riots over the price of basic foods in Mexico and India last year, and in Jakarta, Indonesia, last week. China and Russia have slapped controls on food prices to prevent unrest and inflation. Low-income Americans are feeling the pinch of 10 per cent increases for bread, 19 per cent for milk. Italians boycotted pasta for a day last September in protest at a 7 per cent price hike.

Get set for more, and worse. The recent rises are down to the high price of oil. Food production the world over requires massive amounts of oil for everything from manufacturing fertiliser to shipping grain. It is no accident that as oil hit $100 a barrel last year, maize prices stood at a record $4 a bushel. Prices are unlikely to fall any time soon, says Lester Brown of the Earth Policy Institute, a Washington DC think tank, who has long predicted what is now happening.

Brown, like most observers, also blames the surge in biofuel production, driven by US policy and high oil prices. That boosts demand for grain and oilseeds, pushing up food prices across the board. But there is a more fundamental problem too: there is just not enough land to grow all we need for food and fuel.

Market theory suggests that high prices should lead to increased supply, with more yield per hectare and more hectares planted. Trouble is, there are few unused hectares. "I don't think acreage will increase," says Snow Barlow, head of agriculture at the University of Melbourne, Australia. There is some scope for improving yield - but will it be enough?

That's doubtful. Even as prices for food are rising, so is demand. Population growth adds 200,000 new mouths a day. In addition, says Joachim von Braun, head of the International Food Policy Research Institute in Washington DC, growing prosperity in China, India and elsewhere is boosting demand for meat and other animal products, and it takes 2 to 6 kilograms of grain to produce every kilogram of milk, meat or eggs.

Putting these trends together, basic grain production is predicted to have to increase 2.5 per cent per year for the next 40 years to meet projected demand for food and fuel. Most of this will have to come from yield increases. Yet for decades yields have grown by an average of only 1.5 per cent per year, and as climate change bites it will be hard even to maintain current yields, Barlow says.

The answer should be agricultural R&D. This was what produced the grain mountains of previous years - but that glut led to research cutbacks. Funding for agricultural R&D shrank throughout the 1990s in rich countries, says Julian Cribb of the University of Technology in Sydney, Australia. That should now change. College students take note: now would be a good time to major in agronomy.

Killer wheat fungus threatens starvation for millions

- 13 March 2008
- From New Scientist Print Edition.
- Debora MacKenzie

Enlarge image

Enlarge image
Possible migration routes of wheat rust Ug99

A WHEAT disease that could destroy most of the world's main wheat crops could strike south Asia's vast wheat fields two years earlier than research had suggested, leaving millions to starve. The fungus, called Ug99, has spread from Africa to Iran, and may already be in Pakistan. If so, this is extremely bad news, as Pakistan is not only critically reliant on its wheat crop, it is also the gateway to the Asian breadbasket, including the vital Punjab region.

Scientists met this week in Syria to decide on emergency measures to track Ug99's progress. They hope to slow its spread by spraying fungicide or even stopping farmers from planting wheat in the spores' path. The only real remedy will be new wheat varieties that resist Ug99, and they may not be ready for five years. The fungus has just pulled ahead in the race.

Ug99, a virulent strain of black stem rust (*Puccinia graminis*) was identified in Uganda in 1999. Since then it has invaded Kenya and Ethiopia and, last year, Yemen. From previous fungal invasions, scientists expected the prevailing winds to carry Ug99 spores to Egypt, Turkey and Syria, and then east to Iran, a major wheat-grower, buying them some time. But on 8 June 2007, Cyclone Gonu hit the Arabian peninsula, the worst storm there for 30 years.

"We know it changed the winds," says Wafa Khoury of the UN Food and Agriculture Organization in Rome, because desert locusts the FAO had been tracking in Yemen blew north towards Iran instead of north-west as expected (see Map). "We think it may have done that to the rust spores." This means, she says, that Ug99 has reached Iran a year or two earlier than predicted. The fear is that the same winds could have blown the spores into Pakistan, which is also north of Yemen, and where surveillance of the fungus is limited.

There could be more unpleasant surprises in store. On mature wheat, the fungus reproduces asexually to release billions of identical spores. If the spores drift onto a barberry bush (*Berberis vulgaris*), however, they switch to sexual reproduction, and so could swap genes with other stem rusts to produce completely new variants. Iran is a hotspot for barberry.

Scientists have now found out how Ug99 took hold, says Rick Ward of CIMMYT, the wheat breeding institute in Mexico that started the Green Revolution. "It turns out most of Kenya was planted with a wheat variety that contained only one gene for rust resistance, *SR24*," he told *New Scientist*.

"We advise at least two resistance genes," says Ward. Wheat with the *SR24* gene alone gives any Ug99 strains resistant to *SR24* a huge advantage, just as misuse of antibiotics selects for antibiotic-resistant bacteria, says Ward. Farmers then switched to using wheat with other resistance genes and the same thing happened.

Ug99 is now resistant to the three major anti-rust genes used in nearly all the world's wheat. "The real solution is disease resistance that relies on a number of genes," says Ward. Wheat with multigene resistance does not so much destroy the fungus as slow it down. The hope is that with several genes involved it will be much harder for the fungus to become resistant and there will be less selection pressure for it to do so.

A breeding programme by CIMMYT and others has now uncovered some wheat types which "show promise" in tests against Ug99 in Kenya and Ethiopia, says Ronnie Coffman of Cornell University in Ithaca, New York, who chairs the programme. Funding has increased, as rich countries such as Canada and the US worry that Ug99 could hit their breadbaskets, accidentally or deliberately.

Without such fears, says Khouri, "it is hard to convince donors to take preventive actions, when people are not starving now". But that may not be far off. "People will start starving if Ug99 cuts harvests enough to push up grain prices," warns Ward.

The problem is that crop breeding is slow. It usually takes at least five years to cross disease-resistant lines with wheat varieties adapted to local conditions in the world's wheat-growing countries, then grow enough seed to plant fields threatened by Ug99.

New Scientist has learned that China started a crash programme to breed resistance into Chinese wheat varieties last year, after an article on Ug99 in this magazine was translated into Chinese and circulated to top agriculture officials.

March 16, 2009

To: Board County Commissioners
Latah County
PO Box 8068
Moscow, ID 83843

tstroschein@latah.id.us
jnelson@latah.id.us
jbarrett@latah.id.us
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Latah County Planning Commission
c/o Michelle Fuson, Director
Planning and Building Department
Latah County
PO Box 8068
Moscow, ID 83843

pb@latah.id.us

Re: Comments on Input to Comprehensive Plan Update, Other Issues

Dear County Commissioners and Planning Commission members:

The following is a written summary and amplification of remarks made at the last meeting of the Latah Planning Commission with reference to the process of updating the comprehensive plan.

Language of the Comprehensive Plan

The county comprehensive plan contains two types of statements of note: factual statements and value expressions.

Example of **factual** statements from the current comprehensive plan:

> Fire services are located in Moscow, Potlatch, Kendrick, Juliaetta, and Bovill.
>
> The Moscow-Latah County Library System consists of seven branches throughout the county.

Examples of **value** expressions from the current comprehensive plan:

> Minimize commercial strip development.

Maintain sustainable groundwater resources and prevent of groundwater quality.

From where the Values of the Comprehensive Plan should come

Please note that the county comprehensive plan applies **only** to the unincorporated areas of the county. Incorporated areas have their own comprehensive plan.

Input on **factual matters** including water resources, soils, productivity, etc can come from anyone, including experts or others with specific knowledge regardless of their geography. However, the weight given this kind of testimony ought be determined by credentials or experience of those submitting testimony, which credentials and/or experience would demonstrate the likelihood of the correctness of the testimony.

More importantly though, the county comprehensive plan is designed to reflect the **values** of those living or owning real property within its jurisdiction, the unincorporated areas of the county.

Therefore, in designing and/or amending the comprehensive plan, to discover the **values** of those under its jurisdiction, **only** the input of those under its jurisdiction should be given weight, to wit, those that reside in, or own real property in the unincorporated areas of the county.

It's not rocket science to know that many of the **values** of the majority of those who choose to live in the countryside (unincorporated areas) are very different from those who chose to live in cities (incorporated), particularly with regard to water and other natural resources, wildlife, land use, and privacy. It is the values of the former, not the latter, that belong by law in the comprehensive plan.

In the areas of unincorporated lands within the areas of impact surrounding incorporated areas, citizen input on these areas are to be given on the comprehensive plan enacted for the specific incorporated areas.

The Idaho legislature should not give preference to input from California, Oregon, or Washington, if that input conflicts with that of Idahoans. The constitutional duty of the Idaho legislature is to consider Idaho citizens first, not to those of other states and not to special interest groups.

Correspondingly, the statutory duty of the Latah County Planning Commission is to enact legislation in the interests of and reflecting the **values** of those living in or owning real property in the unincorporated areas, and not those living in the incorporated areas.

One example: Most realtors live in the incorporated areas of Latah County.

The goal of realtors in general is to list and to sell as many properties as possible, hence realtor **values** generally tend to support much more land division and division of land into smaller parcels than the **values** of the majority of those actual living in the unincorporated areas.

Further, if recent experience is any guide, realtor **values** fail to consider the needs, natural resources available to, and life style of residents currently living in the unincorporated areas.

Therefore, input from realtors not living in or nor owning property in the unincorporated areas of the county should not only receive **no** weight, but the planning commission needs to guard itself very carefully from giving any kind of accommodation to or special treatment to them.

The same as above can be said of land speculators who own land in the unincorporated areas, but do not dwell on that land. Recent experience has clearly demonstrated that almost all land speculators looking to divide/develop land in the unincorporated areas upon which they do not dwell have very little, if any, regard for the values, supporting natural resources, and well being of those residents the development would adversely impact.

Although land speculators owning land in the unincorporated areas on which they do not dwell should have some weight given to their testimony, in my opinion that weight should be far less that that given to those that actually reside on such land.

The reasoning for this opinion is as follows:

The over-rule again is, the comprehensive plan should reflect the **values of those living in or owning property in the unincorporated areas**, and not the **values** of any one else.

A very important aspect of the county comprehensive plan and the resulting county zoning ordinances is that one of its main purposes is to protect the property, property values, supporting natural resources, and lifestyle of those **already living** in the unincorporated areas.

Land speculators do not have an automatic right to a return on their investment as some speculators argue. Investments always have risks. When making an investment in land for future division and profit, the investors ought to weigh the risks and rewards of that investment.

If they invest in land where further division is contrary to the existing comprehensive plan elements and/or existing zoning ordinances, the planning/zoning commissions have no obligation to protect the speculators' investment by changing and/or stretching the ordinary language interpretation of the plan/ordinances.

Quite the contrary.

Repeat: A very important aspect of the county comprehensive plan and the resulting county zoning ordinances is that one of its main purposes is to protect the property, property values, lifestyle, and supporting natural resources of those already living in the unincorporated areas.

To recap:

The weight of given to the testimony on the **values** in the comprehensive plan from those not living within the jurisdiction of the plan, the unincorporated areas of the county, should be **zero**.

The weight of given to the testimony on the **values** in the comprehensive plan from those land speculators who own land in the unincorporated area but do not reside there should be considerably less than the weight given to those who actually reside there and whose property values, lifestyle, and quality of life depend on maintaining the integrity of and the supporting natural resources found in their neighborhoods.

Suggestions

If the planning commission and/or the county commissioners agree with the above, then at all future occasions where input is heard or written/other media input is received, then those giving such input ought be required to state whether they live or own property in the unincorporated areas or not. If they own property but do not reside upon it, they ought be required to state whether they intend to reside on such property and/or intend to divide it further for profit.

This sounds a bit draconian. However, I cannot think of any other way to prevent the **values** found in the comprehensive plan from being contaminated by the desires of those living outside its jurisdiction or with interests adverse to those living in that jurisdiction, the unincorporated areas of the county.

Further, I urge, as I am sure that all of my neighbors also do, that explicit protection is given to current residents of the unincorporated of the county by including language similar to that cited just below, and that similar language be added to the current zoning language.

> "The Latah County Planning Commission, the Latah County Zoning Commission, and the Latah Board of County Commissioners recognize the changing residential patterns in Latah County. It is known that more and more clustered and scattered residential development is occurring in rural areas once mostly open space. The Commissions and Board recognize that the primary financial assets of most families are found in their investment in their homes and land, in the lifestyle inherent

> in the location of their homes and land, and the local natural resources necessary to sustain such.
>
> Accordingly, the Commissions and the Board find that an extremely important part of its duties consists of protecting the enormous amount of financial assets inherent in its citizens' homes and land holdings, protecting their lifestyles, and protecting the natural resources supporting such.
>
> Therefore, it shall be the policy of the Latah County Planning Commission, the Latah Zoning Commission, and the Board of Commissioners of Latah County that in all planning and zoning matters where significant conflicts arise between any development and any existing county residential uses, especially where those impacts would have adverse financial and lifestyle impacts on the existing residents, their successors, and on the supporting natural resources, such conflict shall be resolved in favor of the existing residential uses."

I also hope that when planning commission members finally complete a first draft of the proposed changes to the comprehensive plan, that a number of informal hearings/workshops are held to discuss and possibly to make changes to the first draft before a final draft is set for the first formal public hearing.

One reasons for this hope/request that the minutes of the Planning Commission for the last few months have not contained enough information for those who wish to discover and understand the thinking and direction of the Planning Commission. Another reason is that once the thinking and direction of the commission is known through the first draft, the commission, being human and therefore not immune from error, needs to hear viewpoints to what they have contingently proposed before such proposal becomes relatively set in concrete and minds become less flexible.

Thank you for your careful consideration of my remarks.

/s/ Wayne A. Fox

Wayne A. Fox
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Moscow, ID 83843

(208) 882-7975
waf@moscow.com

March 15, 2009

From: Kyle Hawley
1052 Lewis Rd
Moscow, ID 83843

Re: RZ 780: Lewis/Foothill Roads

To: Latah County Commissioners:

My wife Lisa and I have lived at this location since 1974. We have farmed in Latah County 1978. Our land borders the 135 acres owned by the applicants on two sides (approximately ¼ mile for each side). We oppose the proposed rezone for the following reasons:

1. Our home depends on a natural spring fed cistern type well. We believe that the drilling of wells and the water use associated with the proposed homes will put our water supply at great risk. We also have three other natural springs on our property that supply water to two ponds. One pond supplies water for livestock and for the irrigation of our lawn and garden. Both ponds are used by wildlife and recreation, and most likely will someday be used for fire suppression. One spring is undeveloped. We believe that the drilling of four or more wells (the wells will most likely all be up slope from our water sources) will very likely serve as a zone of interception severely impacting these natural springs.

2. We believe that the application is in direct conflict with the first objective of the Latah County Comprehensive Plan. ...The objective is for: the preservation of agricultural and forest land uses to ensure the continued viability of agriculture and forest based economy in rural Latah County. We believe that this zone change would be in direct conflict with the spirit of the Comprehensive Plan and would ignore the will of the majority of the citizens of Latah County.

3. We believe the application does not meet the five rezone criteria of the Latah County Land Use Ordinance as stated in section 6.01.02. They read as follows:

    A. The rezone is in accordance with the goals and policies of the Comprehensive Plan. ...It is not. It does not meet the first objective as stated above.

    B. The rezone, and the uses it permits, shall not be detrimental to or incompatible with the surrounding area, and the uses permitted in that area. ...The rezone uses are detrimental and incompatible with the agricultural uses. Dust, noise, spraying of pesticides, etc. associated with agricultural practices often conflict with residential dweller's expectations. Houses built in the middle of an agricultural landscape exacerbate these conflicts as well as often limit the farmer's crop and agricultural management choices and reduce field efficiencies.

    C. The rezone must provide some public benefit that exceeds any costs imposed upon the public. ...What public benefit does the rezone bring that out weighs the risk to water quantity and water quality (wells/groundwater interaction; and concentrated flows off the buildings and roads onto fields and into county road drainages) and the conflicts and incompatibility with surrounding agricultural uses? There are currently more that one hundred parcels of land for sale in Latah County. Many opportunities exist for people to build homes on parcels of land. The only benefit is monetary, for the applicants.

D. The rezone shall not impose a significant burden to any public services. ...More people in the rural sector equates to more services required. (Road maintenance, police services, fire protection etc.) One could try to argue that that a few homes are not a significant burden however, every new home adds to the cumulative effect of an ever increasing demand for more public services.

E. The rezone shall not be a spot zone. ...The rezone is a spot zone. The proposed zone change is completely surrounded by an actively farmed agricultural landscape and the agriculture/forestry zone.

4. The application states that the land to be rezoned is comprised of less productive agricultural land. This is not correct. The land consists of two soils; they are classified as Southwick, and Larkin. The two soils are very common agricultural soils in Latah County. I farm several hundred acres of these soils. These soils produce profitable crops for many farmers of the eastern portion of the Palouse prairie. I certainly would agree with the Comprehensive Plan's classification of these soils as productive. (Section 8.01.02 of the Latah County Land Use Ordinance). The specific rezone proposal is for a broad rolling ridge line that probably yields comparable to the average yield of the remainder of the field. The fact that the land has been continuously farmed for at least eighty years (probably 125 years) proves that the land is productive and profitable.

5. The applicant/developer purchased the land knowing that it had just been rejected for the same type of zone change proposal as what they are currently asking for.

6. The applicant tries to "green" the proposal by stating that a portion of the remaining land will be transferred into a conservation use and the other remaining land will 'most likely" remain in an agricultural use with the exception of wells and roads. ...The land is already protected in a "green" use (agricultural production) via the existing agriculture/forestry zone. The applicant is in reality asking for a portion of the land to be "unprotected".

7. If the zone change is approved this will set a precedent establishing that the Comprehensive Plan is conveniently manipulated (zones changed) so that agricultural land throughout Latah County can be easily be taken out of production and the land used for housing..

8. The passage of the zone change, as it sets the above mentioned precedent, would not only invite more development which increases farmer/residential conflicts, and increased public service costs, but would directly cause land values to rise. The higher land values result in the inability of young farmers (and future generations of farmers) to purchase agricultural land and also for existing farmers to purchase land from landlords or from those that inherit agricultural lands.

9. Most of us agricultural producers in Latah County have invested in conservation management tools and techniques to conserve our soils for the future; to produce food for future generations. Why do we promote land stewardship but at the same time allow farmland destruction for houses? How do we (as this current living generation) justify destroying farmland for the sake of a few privileged people. What will be the price paid by future generations for our shortsightedness?

10. This generation and future generations of people need every acre of farmland if we are to be less dependent on foreign oil and more reliant on farmland to provide food, fiber, and fuel.

Thank you for your consideration.

Kyle Hawley & Lisa Hawley

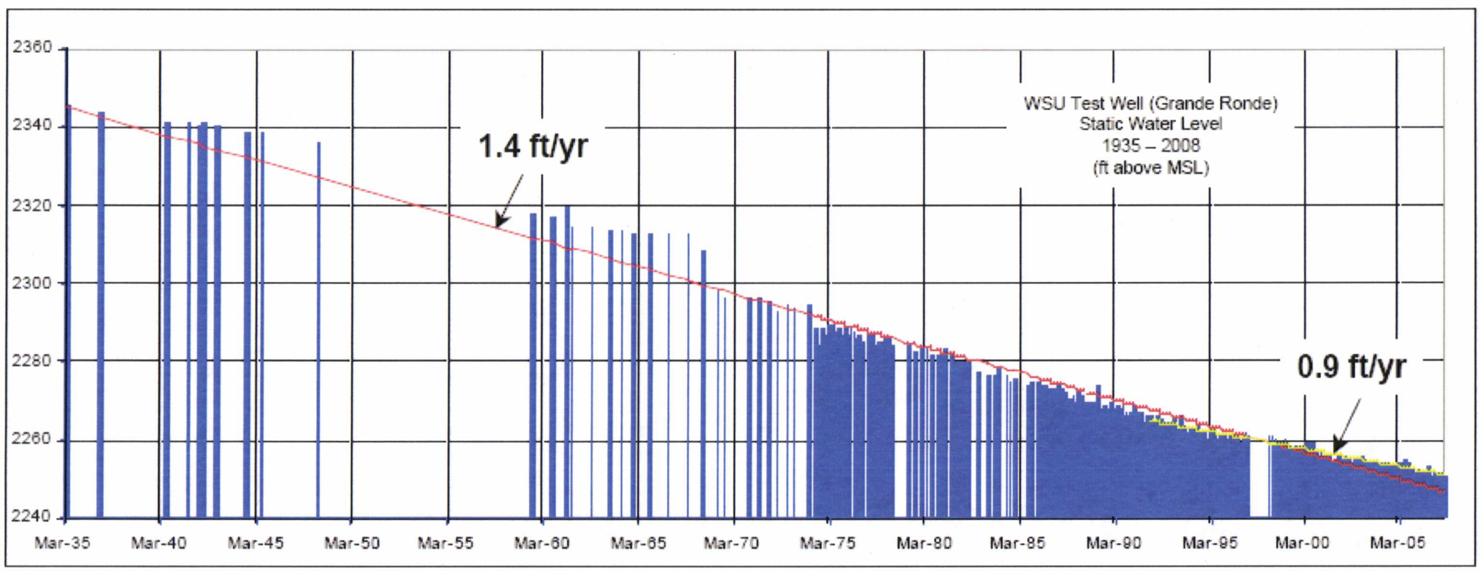
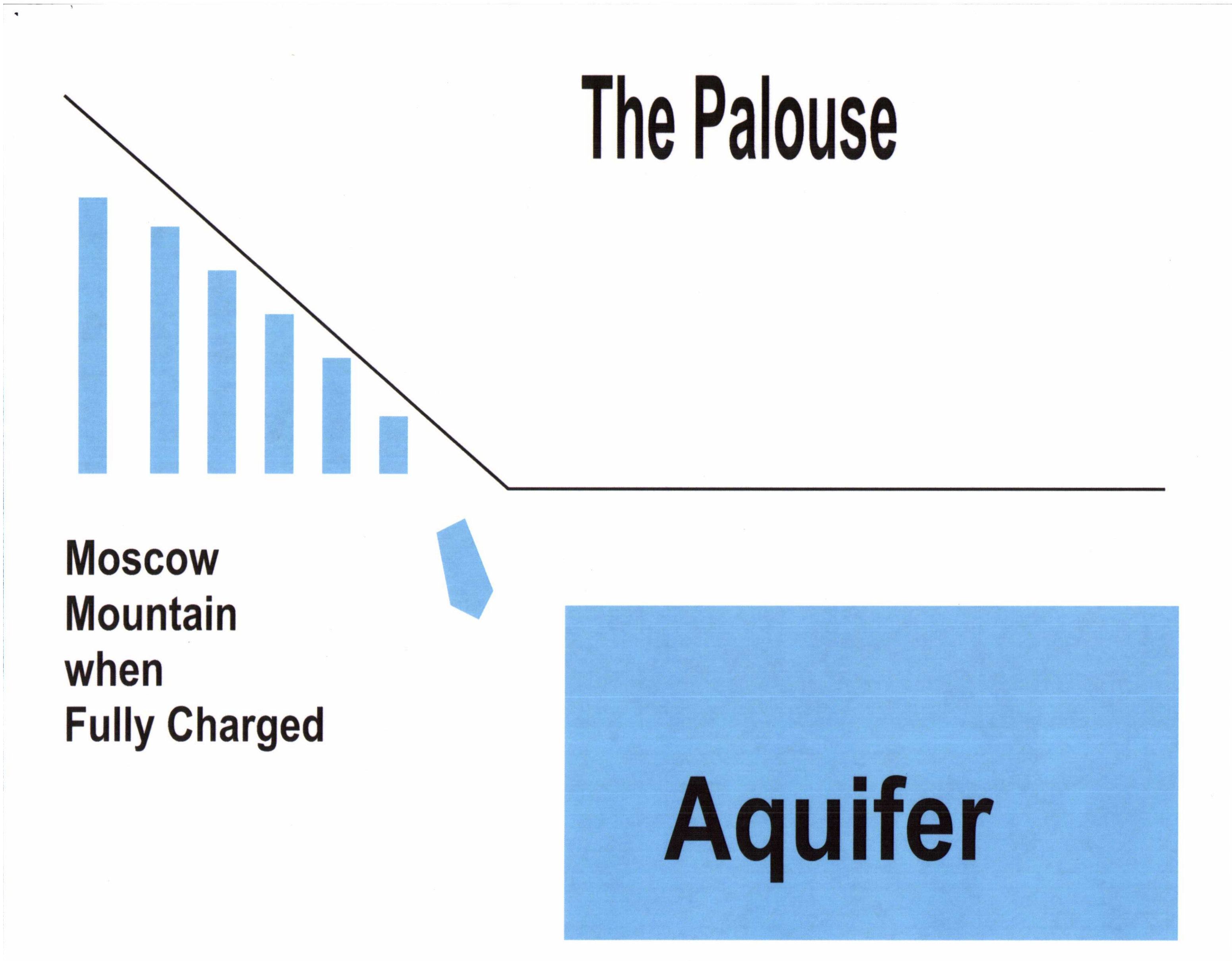
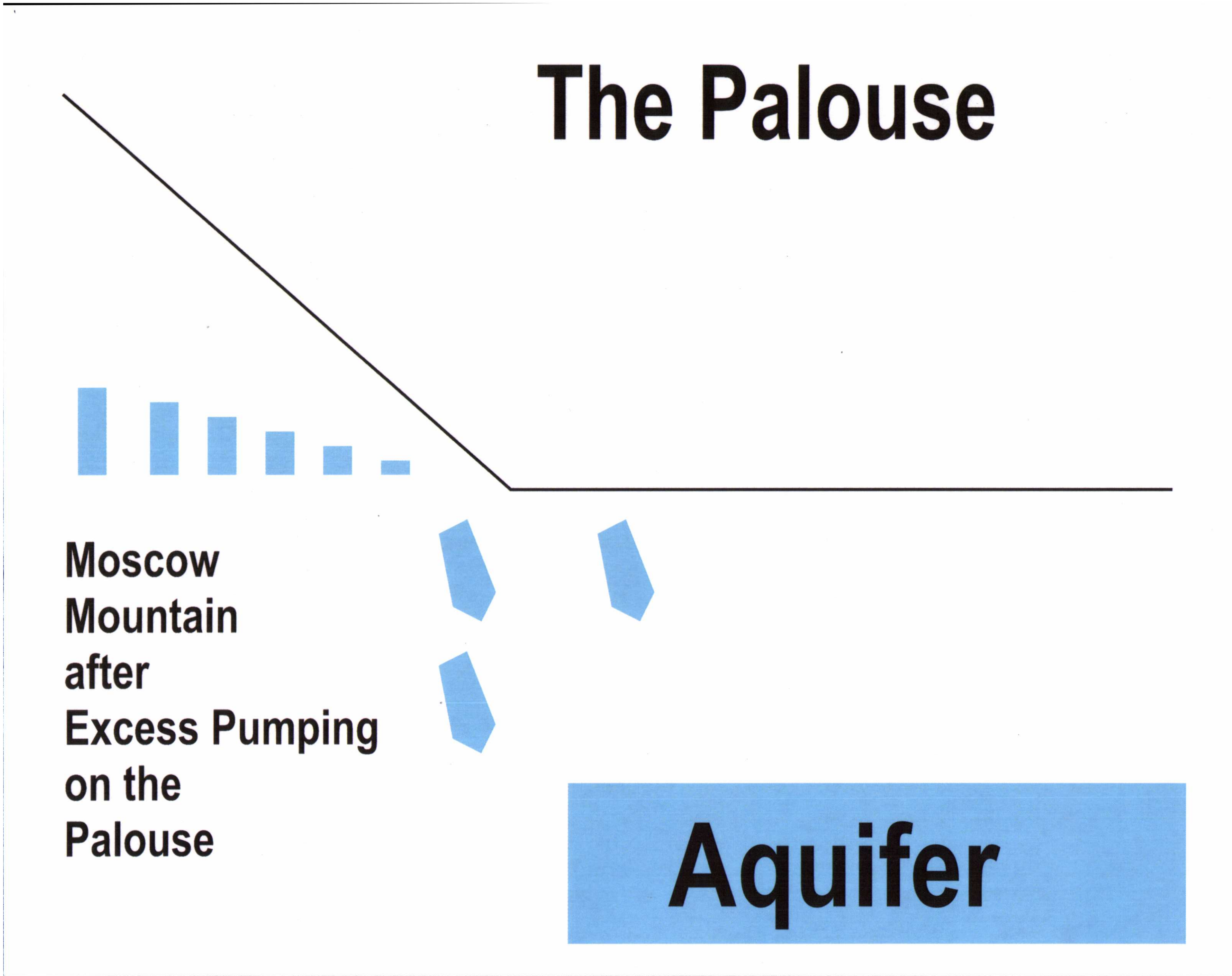


Figure 4: Static Water Level, WSU Test Well, 1938-2008


The Palouse
Moscow
Mountain
when
Fully Charged
Aquifer


The Palouse
Moscow
Mountain
after
Excess Pumping
on the
Palouse
Aquifer

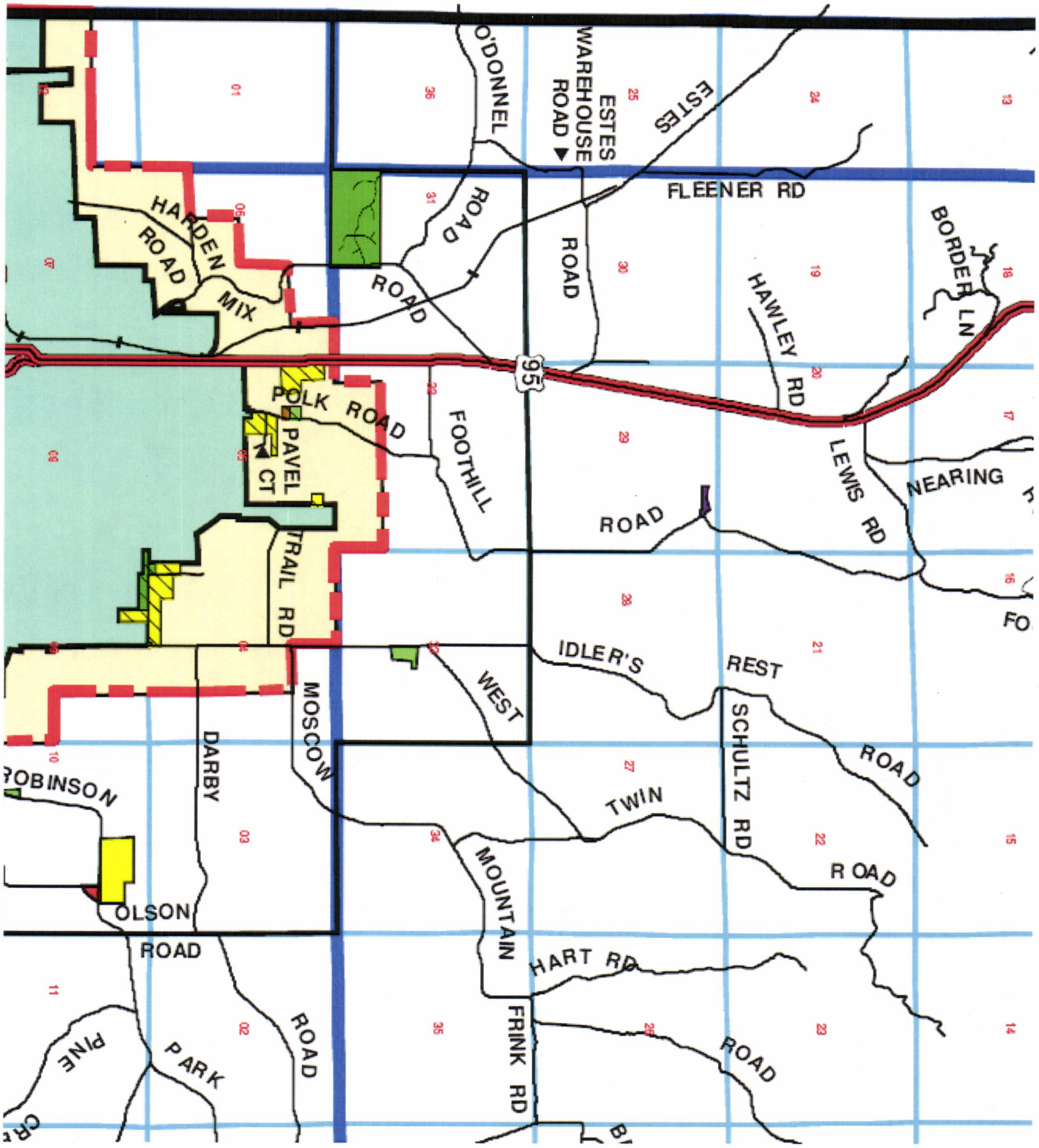

O'DONNEL
ESTES
WAREHOUSE
ROAD
ESTES
FLEENER RD
HARDEN
ROAD
MIX
ROAD
ROAD
ROAD
BORDER LN
HAWLEY RD
95
POLK ROAD
PAVEL
CT
FOOTHILL
LEWIS RD
NEARING
ROAD
TRAIL RD
IDLER'S
REST
WEST
MOSCOW
SCHULTZ RD
ROAD
ROBINSON
DARBY
TWIN
ROAD
MOUNTAIN
OLSON
ROAD
HART RD
FRINK RD
ROAD
PINE
PARK
ROAD


Image © 2008 DigitalGlobe
© 2008 Tele Atlas
©2008 Google™

BOCC HRG: RZ 780
Applicant: BGB LLC.
Exhibit No. 150
Date: March 31, 2009

3.3.5.2 Solar water heating

A. Install SRCC-rated solar water heating system

___ 8 Solar fraction: 0.3
___ 10 Solar fraction: ≥ 0.5

3.3.5.3 Additional renewable energy options

A. Supply electricity needs by onsite renewable energy source whereby the system is estimated to produces the following KWh per year:

___ 8 2,000 – 3,999
___ 10 4,000 – 5,999
___ 12 6,000 +

B. Provide clear and unshaded roof area (+/- 30 degrees of south or flat, minimum 200 square feet) for future solar collector or photovoltaics. Provide rough-in piping from the roof to the utility area

___ 3 Conduit
___ 5 Insulated piping

C. ___ 2 Provide homeowner with information and enrollment materials about options to purchase green power from the local electric utility.

3.3.6 Verification

3.3.6.1 ___ 8 Conduct onsite third-party inspection to verify installation of energy-related features
3.3.6.2 ___ 8/per Conduct third-party testing to verify performance: blower door, duct leakage, flow rates

3.3.7 Innovative Options

A. ___ 2 Install drainwater heat-recovery system
B. ___ 6 Install de-superheater in conjunction with ground-source heat pump
C. ___ 6 Install heat pump water heater rated to current DOE test standard and with EF > 1.7

Section Total ________

Section 4: Water Efficiency

4.1 Water Use

	Your score	Available points	
4.1.1	___	6/per	Hot water delivery to remote locations aided by installation of: A. On-demand water heater at point of use served by cold water only B. Control-activated recirculation system
4.1.2	___	9	Water heater located within 30 feet pipe run of all bathrooms and kitchen
4.1.3	___	7/per	ENERGY STAR water-conserving dishwasher, washing machine, etc.
4.1.4	___	2/per	Water-efficient showerhead using aerator/venturi with flow rate < 2.5 gpm
4.1.5	___	2/per	Water-efficient sink faucets/aerators < 2.2 gpm
4.1.6	___	4-6	Ultra low flow (< 1.6 gpm/flush) toilets: (power-assist: 4 pts; dual flush: 6 pts)
4.1.7	___	7	Low-volume, non-spray irrigation system installed such as drip irrigation, bubblers, etc.
4.1.8	___	6	Irrigation system zoned separately for turf and bedding areas
4.1.9	___	7	Weather-based irrigation controllers such as computer-based weather record
4.1.10	___	9	Collect and use rainwater, as permitted by local code
4.1.11	___	7	Innovative wastewater technology as permitted by local code

4.2 Innovative Options

4.2.1	___	6	Shut-off valve, motion sensor, or pedal-activated faucet for intermittent on/off operation
4.2.2	___	6	Separate and re-use greywater as permitted by local code
4.2.3	___	6	Composting or waterless toilet as permitted by local code

Section Total ________

Section 5: Indoor Environmental Quality

5.1 Minimize potential sources of pollutants

	Your score	Available points	
5.1.1	___	8	For vented space heating and water heating equipment: A. Install direct vent equipment B. Install induced/mechanical draft combustion equipment
5.1.2	___	6	Install space heating and water heating equipment in isolated mechanical room or closet with an outdoor source of combustion and ventilation air
5.1.3	___	6	Install direct-vent, sealed-combustion gas fireplace, sealed wood fireplace, or sealed woodstove or install no fireplace or woodstove
5.1.4	___	9	Ensure a tightly-sealed door between the garage and living area and provide continuous air barrier between garage and living areas including air sealing penetrations
5.1.5	___	6	Ensure particleboard, medium density fiberboard (MDF) and hardwood plywood substrates are certified to low formaldehyde emission standards
5.1.6	___	6	Install carpet, carpet pad, and floor covering adhesives that hold "Green Label" from Carpet and Rug Institute's indoor air quality testing program or equivalent
5.1.7	___	5	Mask HVAC outlets during construction and vacuum all ducts, boots, and grills
5.1.8	___	3	Use low-VOC emitting wallpaper

5.2 Manage potential pollutants generated in the home

5.2.1	___	7	Vent kitchen range exhaust to the outside
5.2.2			Provide mechanical ventilation at a rate of 7.5 cfm per bedroom + 7.5 cfm and controlled automatically or continuous with manual override. Choose:
	___	7	Exhaust or supply fan(s)
	___	9	Balanced exhaust and supply fans
	___	10	Heat-recovery ventilator
	___	10	Energy-recovery ventilator
5.2.3	___	3	Install MERV 9 filters on central air or ventilation systems
5.2.4	___	4	Install humidistat to control whole-house humidification system
5.2.5	___	6	Install sub-slab depressurization system to facilitate future radon mitigation system
5.2.6	___	9	Verify all exhaust flows meet design specifications

5.3 Manage moisture (vapor, rainwater, plumbing, HVAC)

5.3.1	___	6	Control bathroom exhaust fan with a timer or humidistat
5.3.2	___	6	Install moisture-resistant backerboard under tiled surfaces in wet areas
5.3.3	___	9	Install vapor retarder directly under slab (6-mil) or on crawl space floor (8-mil)
5.3.4	___	6	Protect unused moisture-sensitive materials by just-in-time delivery, storing in dry area, or tenting and storing on raised platform
5.3.5	___	5	Keep plumbing supply lines out of exterior walls
5.3.6	___	4	Insulate cold water pipes in unconditioned spaces
5.3.7	___	4	Insulate HVAC ducts, plenums, and trunks in unconditioned basements and crawl spaces
5.3.8	___	4	Check moisture content of wood before it is enclosed on both sides

Section Total ________

Section 6: Operation, Maintenance, and Homeowner Education

6.1	___	9	Provide Home Manual to owners/occupants on the use and care of the home. *(See Guidelines for details.)*
6.2	___	2	Include optional information in the Home Manual. *(See Guidelines for details.)*
6.3	___	7	Provide education to owners/occupants in the use and care of their dwellings: Instruct homeowner/occupants about the building's goals and strategies and occupant's impact on costs of operating the building. Provide training to owners/occupants for all control systems in the house.
6.4	___	1	Solid waste: Encourage homeowners/occupants to recycle by providing built-in space in the home's design (kitchen, garage, covered outdoor space) for recycling containers

Section Total ________

Section 7: Global Impact

7.1 Products

	Your score	Available points	
7.1.1	___	3	Note product manufacturer's operations and practices (environmental management system)
7.1.2	___	6	Choose low- or no-VOC indoor paints
7.1.3	___	5	Use low-VOC seatants

7.2 Innovative options

7.2.1	___	4	Demonstrate that builder's operations and business practices include environmental management system concepts

There's More to NAHB Green.

This checklist is only a summary and omits pertinent information related to compliance and verification. Further information about the intent of the prescriptions herein and how they are verified for certification purposes can be found at nahbgreen.org. Any questions related to compliance should be directed to your chosen certification verifier or the NAHB Research Center.

Using the online version of this scoring tool at nahbgreen.org as a guide, a builder can request the home receive National Green Building Certification from the NAHB Research Center. The home must be inspected at close-in and when it is finished to verify that the green features chosen are in place.

The Research Center provides local verifier training and accreditation to ensure that certification is consistent, accurate, neutral, and technically rigorous throughout the country.

NAHB Green also includes marketing and advocacy guidance for members and local home building associations to communicate the benefits of green building and the importance of keeping these innovative practices voluntary. HBAs can affiliate with NAHB Green in addition to maintaining current local or regional certifications.

Learn more at
www.nahbgreen.org

It's green building, priced right.

NAHB National Association of Home Builders

1201 15th Street, NW. Washington, DC 20005
800.368.5242 • www.nahbgreen.org

NAHB Model Green Home Building Guidelines Checklist

The NAHB National Green Building Program helps any builder, anywhere build a green home. When you attend the NAHB National Green Building Conference, work toward your Certified Green Professional™ educational designation or plan the green features in your next project using the online scoring tool at nahbgreen.org, you're part of the program.

You can score your home using the NAHB Model Green Home Building Guidelines, the first national rating system for green, single-family homes. The online scoring tool, an explanation of the point system, information on how to score your project to the Bronze, Silver or Gold level and a list of accredited verifiers are all available at nahbgreen.org.

This score sheet will introduce you to the rating system.

Open it up and get started!

NAHB NATIONAL GREEN BUILDING PROGRAM™

Section		Bronze	Silver	Gold
1	Lot Design, Preparation, and Development	8	10	12
2	Resource Efficiency	44	60	77
3	Energy Efficiency	37	62	100
4	Water Efficiency	6	13	19
5	Indoor Environmental Quality	32	54	72
6	Operation, Maintenance, and Homeowner Education	7	7	9
7	Global Impact	3	5	6
	Additional points from sections of your choice	100	100	100
	TOTALS	237	311	395

Section 1: Lot Design, Preparation, and Development

1.1 Select the site to minimize environmental impact

	Your Score	Available Points	
1.1.1	___	7	Avoid environmentally sensitive areas identified through site footprinting process
1.1.2	___	9	Choose an infill site
1.1.3	___	7	Choose a greyfield site
1.1.4	___	7	Choose an EPA-recognized brownfield site

1.2 Identify goals with your team

1.2.1	___	6	Establish a knowledgeable team by identifying team member roles and writing a mission statement that includes project goals and objectives

1.3 Design the site to minimize environmental impact and protect, restore, and enhance the natural features and environmental qualities of the site

1.3.1	___	6	Conserve natural resources
1.3.2	___	6	Site the home and other built features to optimize solar resource
1.3.3	___	5	Minimize slope disturbance
1.3.4	___	6	Minimize soil disturbance and erosion
1.3.5	___	8	Manage storm water using low impact development
1.3.6	___	8	Devise landscape plans to limit water and energy demand
1.3.7	___	5	Maintain wildlife habitat

1.4 Develop the site to minimize environmental intrusion during onsite construction

1.4.1	___	5	Provide onsite supervision and coordination during clearing, grading, trenching, paving, to ensure targeted green development practices are implemented
1.4.2	___	5	Conserve existing onsite vegetation
1.4.3	___	6	Minimize onsite soil disturbance and erosion

1.5 Innovative Options

1.5.1	___	6	Share driveways or parking.

Section Total ________

Section 2: Resource Efficiency

2.1 Reduce the quantity of materials used and waste generated

	Your Score	Available Points	
2.1.1	___	3	Create an efficient floor plan that maintain home's functionality
2.1.2	___	8	Employ advanced framing techniques
2.1.3	___	6	Use building layouts that maximize resources and minimize material cuts
2.1.4	___	7	Create a detailed framing plan and material takeoffs
2.1.5	___	4	Use materials requiring no additional finish resources to complete application onsite
2.1.6			Use pre-cut or pre-assembled building systems or methods as outlined below:
	___	3/per	Provide pre-cut joist or pre-manufactured floor truss
	___	6	Provide panelized wall framing system
	___	6	Provide panelized roof framing system
	___	7	Provide modular construction for entire house
2.1.7	___	4	Use a frost-protected shallow foundation

2.2 Enhance durability and reduce maintenance

2.2.1	___	6	Provide covered entry (awning, covered porch) at exterior doors
2.2.2	___	7	Use recommended-sized roof overhangs for the climate
2.2.3	___	7	Install perimeter drain for all basement footings sloped to discharge to daylight, sump pit
2.2.4	___	6	Install drip edge at eave and gable roof edges
2.2.5	___	6	Install gutter and downspout system to divert water 5 feet away from foundation
2.2.6	___	7	Divert surface water from all sides of building
2.2.7	___	7	Install continuous and physical foundation termite barrier where necessary
2.2.8	___	7	Use termite-resistant materials for walls, floor joists, trusses, exterior decks, etc.
2.2.9	___	8	Provide a water-resistant barrier behind the exterior veneer or siding
2.2.10	___	5	Install ice flashing at roof edge
2.2.11	___	7	Install enhanced foundation waterproofing
2.2.12	___	9	Employ and show on plans all flashing details

2.3 Reuse materials

2.3.1	___	6	Disassemble existing buildings instead of demolishing
2.3.2	___	5	Reuse salvaged materials
2.3.3	___	6	Provide onsite bins or space to sort, store scrap materials

2.4 Recycled content materials

2.4.1	___	3	Use recycled-content building materials. List components used

2.5 Recycle waste materials during construction

2.5.1	___	7	Develop and implement a construction and demolition waste management plan
2.5.2	___	5	Conduct onsite recycling efforts
2.5.3	___	6	Recycle construction waste offsite

2.6 Use renewable materials

2.6.1	___	3-5	Use materials manufactured from renewable resources
2.6.2	___	4/per	Use certified wood and use wood-based materials from certified sources

2.7 Use resource-efficient materials

2.7.1	___	3	Use products that are composed of fewer resources

2.8 Innovative Options

2.8.1	___	5	Use locally available, indigenous materials
2.8.2	___	8	Employ a life-cycle assessment tool to choose environmentally preferable products

Section Total ________

Section 3: Energy Efficiency

3.1 Minimum Energy Efficiency Requirements

	Your Score	Available Points	
3.1.1	Mandatory		Home is equivalent to the IECC 2003 or local energy code, whichever is more stringent
3.1.2	Mandatory		Size space heating and cooling system and equipment according to building heating and cooling loads calculated using ANSI/ACCA Manual J 8th edition or equivalent
3.1.3	Mandatory		Conduct third party plan review to verify design/compliance with Energy Efficiency section

3.2 Performance Path

3.2.1 Home is X% above IECC 2003

___	37	15% (Bronze)
___	62	30% (Silver)
___	100	40% (Gold)

3.3 Prescriptive Path

An energy-efficiency practice identified with a "(PP)" in Section 3.3 is a Performance Path practice likely to be used to calculate X% above ICC IECC in Section 3.2. If Section 3.3 is used to obtain points in addition to points from 3.2, those practices from Section 3.3 used to comply with Section 3.2 shall not be awarded any additional points.

3.3.1 Building Envelope

Increase effective R-value of building envelope using advanced framing techniques, continuous insulation, and/or integrated structural insulating system. Measures may include but are not limited to:

A. (PP)	___	8	SIP, or
	___	8	ICF, or
	___	6	Advanced framing or insulated corners, intersections and headers
	___	2	Raised heel trusses
	___	4	Continuous insulation on exterior wall
	___	4	Continuous insulation on cathedral ceiling
B. (PP)	___	10	Air sealing package is implemented to reduce infiltration
C. (PP)	___	8	ENERGY STAR®-rated windows appropriate for local climate

3.3.2 HVAC design, equipment, and installation

A.	___	8	Size, design, and install duct system using ANSI/ACCA Manual D* or equivalent
B.	___	8	Design radiant/hydronic space heating systems using industry-approved guidelines
C.	___	8	Use ANSI/ACCA Manual S* or equivalent to select heating and cooling equipment
D.	___	8	Verify performance of the heating and cooling system
E.	___	6	Use HVAC installer or technician certified by national or regionally recognized program
F. (PP)			Fuel-fired space heating equipment efficiency (AFUE)
	___	4	Gas furnace ≥ 81%
	___	6	Gas furnace ≥ 88% (ENERGY STAR)
	___	8	Gas furnace ≥ 94%
	___	2	Oil furnace ≥ 83%
	___	2	Gas or oil boiler ≥ 85% (ENERGY STAR)
	___	6	Gas or oil boiler ≥ 90%
G. (PP)			Heat pump efficiency (cooling mode)
	___	6	SEER 13-14
	___	6	SEER 15-18
	___	7	SEER 19+
	___	9	Staged air conditioning equipment
H. (PP)			Heat pump efficiency (heating mode)
	___	6	7.2 - 7.9 HSPF
	___	7	8.0 - 8.9 HSPF
	___	9	9.0 - 10.5 HSPF
	___	10	> 10.5 HSPF
			Note: *Split systems must be ARI-tested as a matched set.*
I. (PP)			Ground source heat pump installed by a certified geothermal service contractor (cooling mode)
	___	5	EER = 13-14
	___	6	EER = 15-18
	___	8	EER = 19-24
	___	10	EER = >25
			Note: *For Sections A-F and I, add 3 points if Manuals S and D and start-up procedures are followed when units are installed.*
J. (PP)			Ground source heat pump installed by a certified geothermal service contractor (heating mode)
	___	6	COP 2.4 - 2.6
	___	8	COP 2.7 - 2.9
	___	10	COP ≥ 3.0
K.	___	6	Seal ducts, plenums, equipment to reduce leakage. Use UL 181 foil tapes and/or mastic.
L.	___	8	When installing ductwork: 1. Do not use building cavities used as ductwork, e.g., panning joist or stud cavities 2. Install all heating and cooling ducts and mechanical equipment within conditioned envelope 3. Do not install ductwork in exterior walls
M.	___	6	Install return ducts/transfer grilles in rooms with doors (except baths, kitchen, closets, laundry)
N.	___	1/per	Install ENERGY STAR-rated ceiling fans
O.	___	4	Install whole-house fan with insulated louvers
P.	___	8	Install ENERGY STAR-labeled mechanical exhaust for every bathroom ducted to outside

3.3.3 Water heating design, equipment, and installation

A.	___	4	Water heater Energy Factor equal to or greater than those listed

	Size (gallons)	Energy Factor
Natural Gas:	30	0.64
	40	0.62
	50	0.60
	65	0.58
	75	0.56
Electric:	30	0.95
	40	0.94
	50	0.92
	65	0.90
	80	0.88
	100	0.86
Oil:	30	.59
	50	0.55

B.	___	4	Install whole house instantaneous (tankless) water heater
C.	___	4	Insulate all hot water lines with a minimum of 1" insulation
D.	___	3	Install heat trap on cold and hot water lines to and from the water heater
E.	___	5	Install manifold plumbing system (parallel piping configuration, stacking plumbing)

3.3.4 Lighting and appliances

A.	___	7	Use an ENERGY STAR Advanced Lighting Package
B.	___	7	Install all recessed fixtures within the conditioned envelope
C.	___	7	Install motion sensors on outdoor lighting
D.	___	2	Install tubular skylights in rooms without windows.
E.			Install ENERGY STAR-labeled appliance:
	___	3	Refrigerator
	___	3	Dishwasher
	___	5	Washing machine

3.3.5 Renewable energy/solar heating and cooling

3.3.5.1 Solar space heating and cooling *(See Guidelines for details)*

A.	___	10	Use sun-tempered design: building orientation, sizing of glazing, design of overhangs to provide shading
B.	___	10	Use passive solar design: sun-tempered design as above plus additional southfacing glazing, appropriately designed thermal mass to prevent overheating
C.	___	8	Use passive cooling, including, shading, overhangs, window cross ventilation