Mosier Watershed Council

Community Groundwater Meeting/USGS Final Report
"Mosier Groundwater: New Answers, New Questions"

Mosier Grange Hall

November 18th, 2009, 6:00 – 7:15 PM

MEETING SUMMARY

Attendees:

Peter Kinsey, *co-chair*	Kate Merrick, *coordinator*	Bryce Molesworth	Dave Morgan, *USGS*
Erick Burns, *USGS*	Doug Woodcock, *OWRD*	Terrence Conlon, *USGS*	Ken Lite, *OWRD*
Rick Craiger, *OWEB*	Mel Omeg, *SWCD*	Ron Graves, *SWCD*	Sheila Dooley
Lucy Ward	Katherine Long	Arlene Burns	Josie Balster
Cheryl & Terry Moore	Kelly McCargar	Alexa Dill	Nathan Visser
Wilton & Heidi Hart	Kris McNall	Jim Appleton	Jan Leininger
Karen Bailey	Gary Hebener	Lavonne Povey	David Povey
Jill & Chuck Barker	Kathleen Fitzpatrick	Greg Steers	John Grimm

Note: I have listed slide numbers [in parentheses] to indicate relevant illustrations from the USGS slide presentation when appropriate. The numbers refer to the slides in the associated file: "USGS_Mosier_presentation_DRAFT.pdf." As noted in the file title and the "draft" watermark on the slides, this presentation has not been reviewed or published and is offered only as an informational service to the community, not to be quoted or distributed. ---Kate Merrick

Introduction

Mosier Watershed Council co-chair Peter Kinsey and coordinator Kate Merrick welcomed the audience to the groundwater meeting.

Former Mosier Watershed Council chair and cherry grower Bryce Molesworth introduced the group to why and how the Council started the groundwater study. Mosier-area wells had been dropping at alarming rates, which poses a particularly serious threat to the region's agricultural economy. Aquifer declines have also reduced base flow to creeks. After conducting a Watershed Assessment and considering various natural resource concerns in the region, the Council decided to focus on groundwater as its highest priority. Individual growers contributed the seed money to begin the groundwater study.

USGS Report

Dave Morgan is a groundwater specialist and Erick Burns is a hydrologist with the United States Geological Survey's Oregon Water Science Center in Portland. They were the lead researchers on the Mosier Groundwater Study.

Dave presented an introduction to the Mosier Groundwater Study. The USGS began working on the study in 2005 after discussing plans with the Watershed Council in 2004. The USGS study expanded on some of the earlier geological studies of the Mosier area, such as those conducted by Gay Jervey and Ken Lite. The USGS conducted the Mosier study to advance overall knowledge of geology and to provide the science to support community or policy decisions. Groundwater problems in the Mosier area are similar to issues in other parts of the Columbia River gorge, so the study is relevant beyond Mosier's boundaries.

With the extent of past and current research, the Mosier area may be the best understood location for basalt hydrology.

Dave illustrated the motivation for the study with a graph that showed groundwater levels since the 1940s. The graph indicates an obvious change in the 1970s, after which groundwater levels dropped 175 feet in 37 years! [Slide 3: note that this is the hydrograph for just one well, but the pattern is broadly applicable to many wells in the Mosier area.] These declines are significant to growers, rural residents, and City of Mosier residents alike, because both agricultural and domestic water in the area comes from wells. The declines are also significant to fish that rely on groundwater to moderate stream temperatures and provide sufficient base flow in Mosier, Rock and Rowena Creeks.

Dave outlined the steps in the Mosier Groundwater Study. The USGS researchers:

- Compiled existing information, collected new data, and developed an updated geologic framework
- Estimated a groundwater budget,
- Built a computer simulation model,
- And used the model to test hypotheses.

Dave expanded on the data compilation and collection steps. These steps included:

- o Creating a 3-D model of Mosier-area geology from existing data; [Slide 6]
- o Re-instating stream flow monitoring at the Mosier Creek gauge, which had been in operation from the 1960s – 1980s [Slide 7. Also note that water levels at this gauge are accessible online at http://waterdata.usgs.gov/nwis/uv?14113200.];
- o Measuring connectivity between groundwater and streams [Slide 8];
- o Measuring pumping at 12 irrigation wells throughout the irrigation season for 2 years [Slide 9];
- o Monitoring groundwater levels at about 35 wells, every 2 – 3 months for 3 years [Slide 10] and
- o Testing wells by lowering measuring instruments down well bore holes [Slide 11].

Erick continued the presentation with further description of the problem. As Dave had previously shown, groundwater levels have dropped 175 feet since the 1970s. The earlier well measurements on this graph [Slide 14] were made by the Oregon Water Resources Department (OWRD). Due to the declines as measured in the 1980s, OWRD instituted administrative rules to prohibit new groundwater rights in the Pomona and Priest Rapids aquifers in the Mosier area. The later well measurements, which were made by the USGS during this study, show that those regulations did not slow or stop the declines.

Erick showed the extent of the USGS Mosier Groundwater Study area [Slide 15. Note that the small orange area is the City of Mosier, and the larger shaded area is where OWRD will not issue any new groundwater permits, though domestic wells are exempt from this limitation.]

Erick explained that a large number of wells have shown a pattern of linear decline [Slide 16]. The USGS researchers grouped wells based on their patterns of decline. Group 1 and Group 2 wells, which showed the sharpest declines, are all clustered in the same region of the study area [Slide 17. Note: each color represents a group of wells that show similar patterns in decline].

Next, Erick explained that the study came down to one central question: What is causing the rapid drop in well water levels? The possibilities included pumping (taking out the groundwater faster than it naturally recharges), commingling (water flowing from one aquifer to another through a well that taps multiple aquifers), and climate change. Climate change was dismissed as a major cause because the sudden pattern of groundwater decline is not consistent with climate patterns. Therefore, the culprits were narrowed down to pumping and commingling.

In 2006 there were just over 500 wells in the study area, and about 450 were domestic wells [Slide 19]. Despite the lower number of irrigation wells, irrigation water use accounts for about 80% of groundwater pumpage in the study area. The remaining 20% of groundwater pumpage is split fairly evenly between city wells and all other domestic wells [Slide 20].

Erick explained the Mosier-area water budget and how pumping fits into it. Average annual precipitation is about 30 inches, and about one third of this amount recharges groundwater. Pumping amounts to about 3% of the total groundwater recharge in a given year. Groundwater that is not pumped contributes base flow to streams and the Columbia River.

Next, Erick gave an introduction to Mosier's geology and hydrology. He showed a map of the surface geology in the study area [Slide 25] and highlighted the Columbia River Basalts. He also showed a cross-section through the area, which illustrates the layering in the Columbia River Basalt Group. These Columbia River Basalt layers are the principle aquifers in the region. They were deposited 17.5 to 6 million years ago as huge lava flows coming from near Idaho [Slide 27]. The multiple sheet flows over time resulted in the layered system seen today.

The center of each of these layered lava flows is very dense and thus does not hold or pass much water. The top and bottom of each flow is much more open and connected and allows water to flow through quite easily. The aquifers are found in these "flow tops" and "flow bottoms," while the denser interiors of the flows are confining units that separate aquifers from each other [Slide 28].

Folds and faults in the geology affect the flow of water in aquifers. A fault causes an offset or discontinuity in a water-bearing layer [Slide 29. Imagine that water flows through the narrower layer in the center of this cross-section. What would happen at the fault?]. A complicated system of faults and folds has been mapped in the Mosier area [Slide 30], but even a simplified view of just the main faults can help explain the well groupings that the USGS researchers assigned [Slide 32]. Wells that were grouped together because they show similar patterns of decline are found together within the bounds of the same faults.

Erick talked next about flow paths and what happens in commingling wells. Historically, head (basically the water pressure in an aquifer) has been higher in deeper aquifers than shallower aquifers. Therefore, if given a pathway, water from a deeper aquifer would move up into a shallower aquifer, moving from high head to lower head. A well that taps multiple aquifers acts as that pathway, allowing water from a deeper aquifer to move up through the well and out again into a shallower aquifer. [Slide 34]

After covering the basics of the geology, hydrology, and problematic groundwater declines in Mosier, Erick talked about the groundwater flow model that he and his colleagues created for this study. This computer model is based on principles of *accounting* and *physics*. It accounts for the quantities of water that move in and out of the system. This movement is controlled by the physical properties of the various rock layers.

A model can show how well the model builders understand the system. If the model produces results that closely match real-world observations, the modelers probably had a good understanding of the system. It takes a lot of data to develop a good understanding of the system and a good model. The USGS researchers used all available data to construct the Mosier groundwater flow model, but of course they didn't have data on every single detail of Mosier's hydrogeology. Their goal was to create a model that would capture the substantial behavior of the groundwater system so that it could be used as a tool that would help us understand how the system responds to various influences.

One important concept in modeling is "uncertainty." Basically, there is always some uncertainty in a model. If you can define how much uncertainty there is, you can decide whether your model is operating with an acceptable level of confidence. [Slide 38: weather forecast example] The important point is that you don't need to know every tiny detail with exact precision in order to use whatever information you do have. How does this all relate to the Mosier groundwater flow model? The model will not be an exact replica of reality, but it will be a useful tool because we can understand its level of uncertainty and then interpret and use it results accordingly.

Erick illustrated how geological information is converted to a flow model that represents important features such as rivers, faults, springs, and wells [Slides 39 – 41].

Once the researchers create that model they investigate its "fit," or how well the *modeled* system response matches *actual measurements* of the real-world response. They explore the range of conditions that closely match the real world data. They look for the extremes in this range to help determine how confident they are in the model's predictions. In particular, the model was used to find smallest and largest effects due to pumping and commingling. These extremes tell us how well we can separate the effects of each. In other words, can we decide how much of each process (pumping or commingling) is the cause of the significant declines in well water levels?

To find these extremes, we need to understand how the system will respond if we change only one of them, so next, Erick talked about how Mosier's groundwater system has evolved over time. He illustrated this with a conceptual diagram of well water levels over time [Slide 43]. Up until the 1950s there were no significant wells in the watershed. In the 1950s a few wells were constructed, which caused water levels to fall slightly and then level off. In the 1970s many more wells were constructed. This time the result was a sharper decline in water levels. Looking at the shape of the curve in 2009, it appears that water levels will eventually stabilize again, albeit far below their original level.

As mentioned above, we need to understand what would happen if we change either the pumping or the commingling. What would happen if all well pumping stopped? Without commingling, the water levels would recover to the original levels. With commingling, water levels would recover somewhat but stabilize below the original levels [Slide 45: conceptual illustration]. In the case of the Mosier watershed, how big is the "pumping effect" compared to the "commingling effect?" In other words, how much recovery could be expected if all pumping were stopped, but the inactive commingling wells still remained in the system? We can test this with the model.

Erick showed some predictions of how far water levels would recover if pumping were stopped, assuming that average water levels were to stop declining near their current low point. One model simulation predicts that 50% of the wells will not recover more than 10 feet, and 90% of the wells will not recover more than 20 feet! [Slides 48 – 49]

This is a pretty minimal recovery, but it is only one of many possible simulations that still match the data that was collected. The goal is to find the best and worst case scenarios (the extremes as I mentioned above) that still fit the data well. In the model's best case prediction of recovery without pumping, 50% of the wells will not recover more than about 30 feet, and 90% of the wells will not recover more than about 50 feet [Slide 51]. Since this was the best possible recovery that matches the data, all other cases would have less recovery, indicating that the commingling effect is very significant in the Mosier system.

Measurements made in real Mosier wells support the model's conclusion that commingling is significant. In the city well #3, prior to repairs, about 113 acre-feet per year of water was flowing up through the well from one aquifer and being lost out into a different aquifer. This amount is equal to 12% of the pumping for the entire watershed! The annual loss would have been even higher in the past, before the head difference between aquifers was reduced by this type of leakage.

Given all this information, what are the options for restoring or stabilizing well water levels in the Mosier watershed? Erick briefly outlined a few possibilities.

Commingling wells could be repaired or replaced. Data from the USGS can help identify which wells are likely to be the worst comminglers. Still, more well testing will be required in order to implement repairs.

Aquifers could be used to store surface water taken from Mosier Creek in the winter, for use in the dry summer or for the general purpose of raising groundwater levels. These options are being evaluated in a current study by the Mosier Watershed Council, funded by the Oregon Water Resources Department (OWRD).

Conservation efforts such as irrigation efficiency projects and city water system repairs and metering could be continued or expanded.

Another option would be for the Mosier community to work with OWRD to create new rules regarding well construction in the area. The OWRD could designate special area well construction standards that would require casing to a certain depth or other measures to ensure that future well construction will prevent commingling.

USGS Conclusions

Erick wrapped up his presentation with conclusions about Mosier's groundwater problem and a review of the continuing USGS role in studying the problem.

Commingling is significant in the Mosier groundwater study area, and is probably the dominant cause of well water level declines.

The USGS has generated maps of commingling well vulnerability in the Mosier study area. The maps are color-coded to show how likely it is that a well in a given area will be susceptible to serious commingling. [Slide 55: note that red areas are the worst for commingling and blue areas are the least vulnerable.] These maps can be used to help prioritize wells for repair or help determine where commingling wells may have an impact on an aquifer storage project. The USGS is continuing to refine these maps.

Future USGS involvement will include participation in the Aquifer Storage and Recovery / Artificial Recharge feasibility study. For this study the USGS will use the Mosier groundwater flow model and collect more field data on vertical well flows.

Erick and Dave both thanked the community for their participation and interest in the Mosier groundwater study and took a few questions.

One person asked if groundwater is being lost into Mosier Creek. The answer is a qualified yes. There is likely more water entering Mosier Creek, but it is over a shorter length of lower Mosier Creek. There is actually less groundwater making it into upper Mosier Creek, so upper reaches of the creek are experiencing lower flows. Repairing commingling wells should restore flow further up Mosier Creek, though it may diminish groundwater inflows at some points lower in the creek.

Someone else asked if a sustainable level of development can be predicted based on the conclusions of the groundwater study. Erick explained that the USGS has not made those predictions, since it was outside the realm of the USGS study. Policy decisions on water use are ultimately up to the community in cooperation with OWRD.

Current and Future Watershed Council and Community Actions

Following the USGS presentation, Kate gave a little more information about the options Erick had outlined for restoring or stabilizing Mosier's well levels.

The Mosier Watershed Council and Wasco County Soil & Water Conservation District have applied for several grants to help identify, prioritize, and design commingling well repairs. So far, none have been funded. Because these repairs can be very difficult, the Watershed Council feels that it will be important to prioritize wells to maximize the water savings for the investment put into the repair. The Council wants to find financial support for well owners to make the repairs because the results are expected to benefit the entire community and the watershed resource, not just the well owner.

Last spring, the Mosier Watershed Council received a large grant from Oregon Water Resources Department (OWRD) to study the feasibility of using Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) in the Mosier watershed. Both of these techniques would involve diverting some of the high winter flow from Mosier Creek and storing it underground in an aquifer. The Watershed Council has negotiated an agreement with the USGS to do some of the modeling and data collection for the study, as Erick already mentioned. The USGS model will be used to evaluate some ASR/AR scenarios with and without commingling well repair, to predict the impact that commingling wells may have on the feasibility of ASR/AR.

Continued water conservation efforts are always encouraged, and the Wasco County SWCD can help irrigators design and fund irrigation efficiency projects that will save water. Kate explained that many irrigators have already improved their systems and dramatically reduced their water use.

Kate invited Doug Woodcock, manager of OWRD's groundwater division, to give an overview of the process by which OWRD could designate "special area well construction standards" for Mosier (see Oregon Administrative Rules 690-200 for more details). This process allows any group to petition the state to write additional rules regarding well construction for a particular location based on its particular conditions.

There are three locations in Oregon where special area well construction standards have been written. In the Lakeview area, wells are required to be deep enough to go below a layer of contamination. In the Pete's Mountain area, wells must be installed with a measuring tube. In the Eola Hills area, where commingling wells are a problem, wells must be cased and sealed to within 100 feet of the bottom of the well.

A group that petitions OWRD to create a special area rule comes up with its own request for what the rule will entail. For example, if a group were to petition OWRD for a new Mosier-area rule like the Eola Hills casing rule, the group could come up with its own suggestion for a casing depth.

Kathleen Fitzpatrick asked Doug if he had seen successful repairs of commingling wells. Doug reported that he had. In one Wasco County example, the well opening in a previously commingling well in the Eightmile Creek area was successfully isolated to just one water-bearing zone, though it took three years and multiple attempts. There are many factors that feed into this, and the watershed council is investigating options to ensure that the most effective and efficient methods will be used, in hopes to prevent a similar scenario.

Closing

Kate thanked the presenters and attendees, and invited anyone with further questions to write them down for the presenters to address after a break. Many attendees asked questions during the break, leaving little need to reconvene for formal Q&A afterward.

If you have further questions contact Kate Merrick, Mosier Watershed Council Coordinator, at kate.merrick@oacd.org or (541) 296-6178 x.119.

Questions for the USGS can be directed to Erick Burns at eburns@usgs.gov and 503-251-3250, or to Dave Morgan at dsmorgan@usgs.gov and 503-251-3263.