Open-File Report

The Potential for Recharge at Jensen Grove

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Introduction

Jensen's Grove is a city park, located approximately one mile northwest of downtown Blackfoot, about one-quarter mile east of the Snake River and immediately east of Interstate Highway 15. Figure 1 indicates the location of the study area. According to unconfirmed historical reports, prior to construction of the interstate highway, a meander in the river provided a waterfront and recreational resource to area residents. With the construction of the highway in the 1960s, the meander was isolated from the river, and the site was developed as a source of aggregate for the highway construction. The resulting pit is now filled with water diverted from the river to a canal during irrigation season and occupies approximately 60 acres at maximum pond depth of 20 to 25 feet. Water is diverted into the pond at approximately 25 cfs and retuned to the river through an outlet works. During the non-irrigation season, the pond is empty. In recent years Jensen's Grove has evolved into a park providing recreational benefits to the city's residents.

Jensen's Grove Pond has been thought to possibly provide recharge to the underlying Eastern Snake River Aquifer as well as flow augmentation to the river through reach gains. This study presents hydrologic scenarios that investigate these possibilities, conclusions, and recommendations for further investigations.

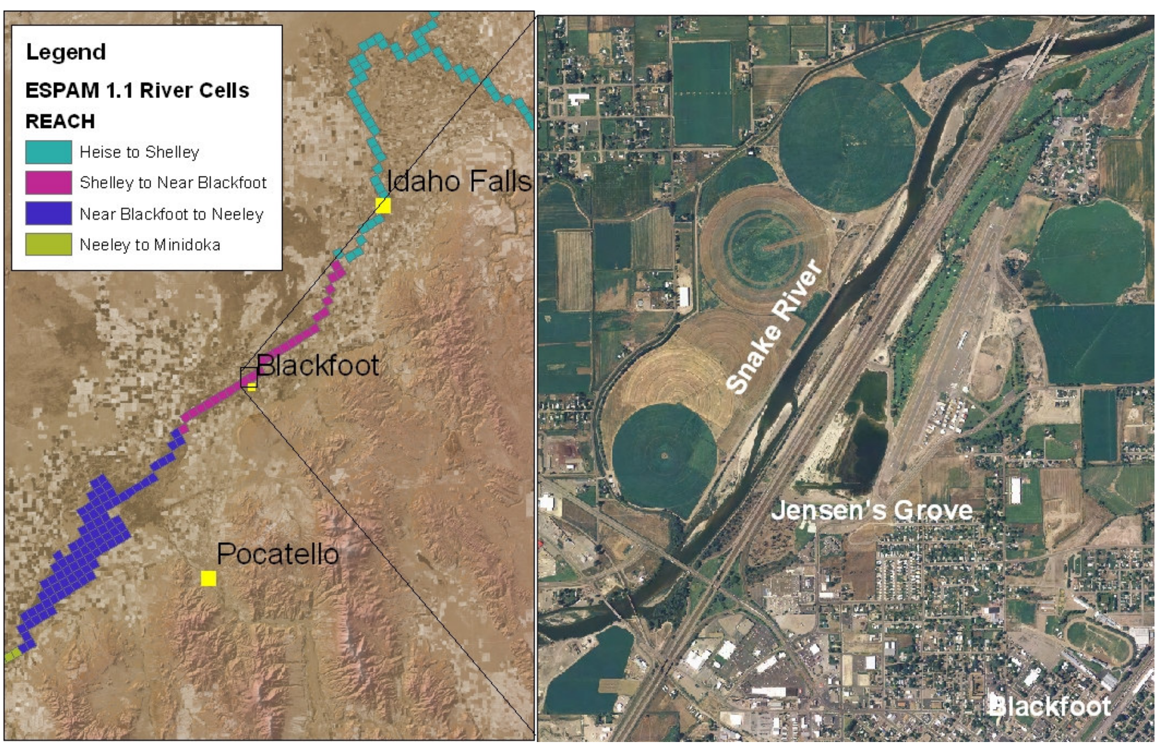

Figure 1. The location of the study area.

Methods

The data gathered for this reconnaissance level study included manual measurements of water stage in the Jensen's Grove pond, manual and data-logger records of water levels in two nearby wells, and altimeter, GPS, and hand-level elevation data. Idaho Department of Water Resources (IDWR) staff conducted the survey-grade GPS work and deployed the data-loggers in the two observation wells. Idaho Water Resources Research Institute (IWRRI) staff collected most of the other observations and made significant contributions to the data analysis.

Figure 1 is a location map, and Figure 2 is a map of the study area showing the data-gathering locations. River 1, River 2 and River 3 are points on the Snake River where elevations were obtained. Bridge is where initial pond stage measurements were made, and where the base elevation for the altimeter work was collected. Its elevation was established by survey-grade GPS. Hand-Level is the location where the hand-level survey was used to correlate shoreline measurements with stage. Its elevation was established by survey-grade altimeter work. The elevation of the two observation wells (Airport Well and Park Well) was also obtained with the survey-grade GPS. Elevation of River 1 was obtained by a survey-grade altimeter, and River 2 and River 3 were extrapolated from River 1 using topographic maps.

Figure 2. Location of key observation points.

Figure 3 illustrates much of the collected data. It shows the water table elevation in the two observation wells in relation to the Snake River and the pond surface in Jensen's Grove. All elevations are relative to the IDWR GPS survey. River elevations were collected only once but are assumed to have been essentially constant over the study period. Note that the water level in the aquifer, as measured in the Park Well, drops shortly after the diversion shutoff date. Also, by November, the water level in the pond drops below the level of saturation in the aquifer. There is no evidence that ground water flows from the aquifer into the pond. The pond was dry in all visits after January 13, 2009.

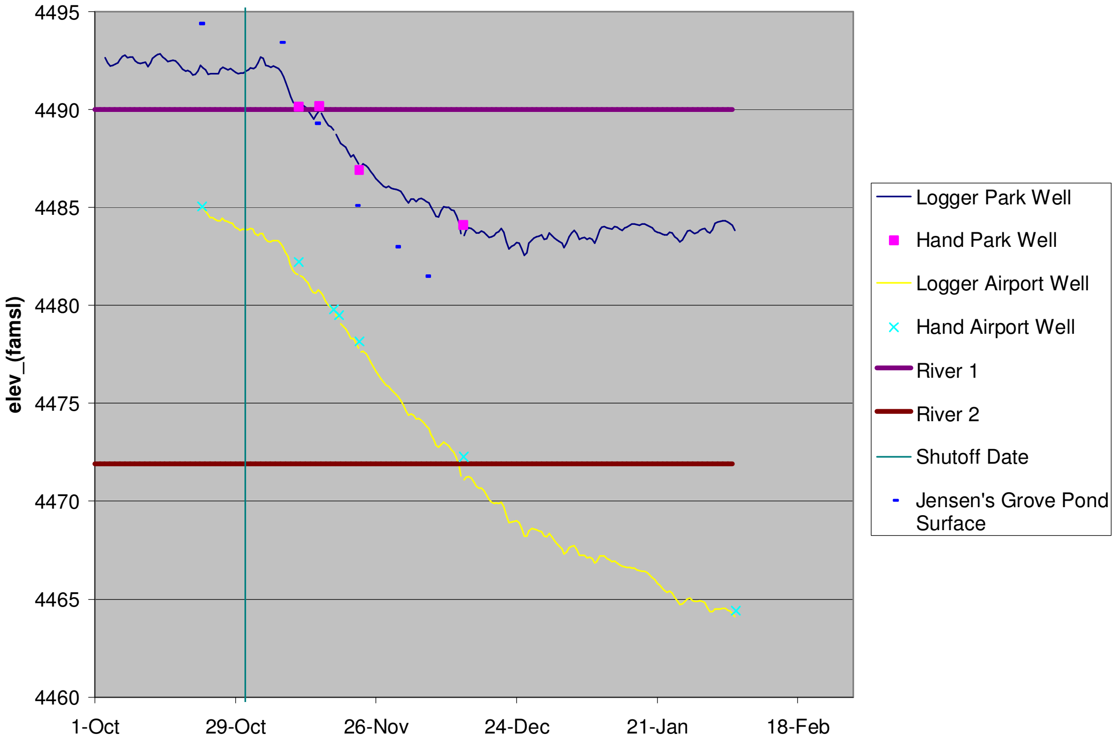

Figure 3. Hydrograph showing water level in Jensen's Grove, the two observation wells, and the Snake River.

Analysis

Figures 4 though 6 are conceptual models that illustrate scenarios in which the Snake River, Jensen's Grove and the aquifer might interact.

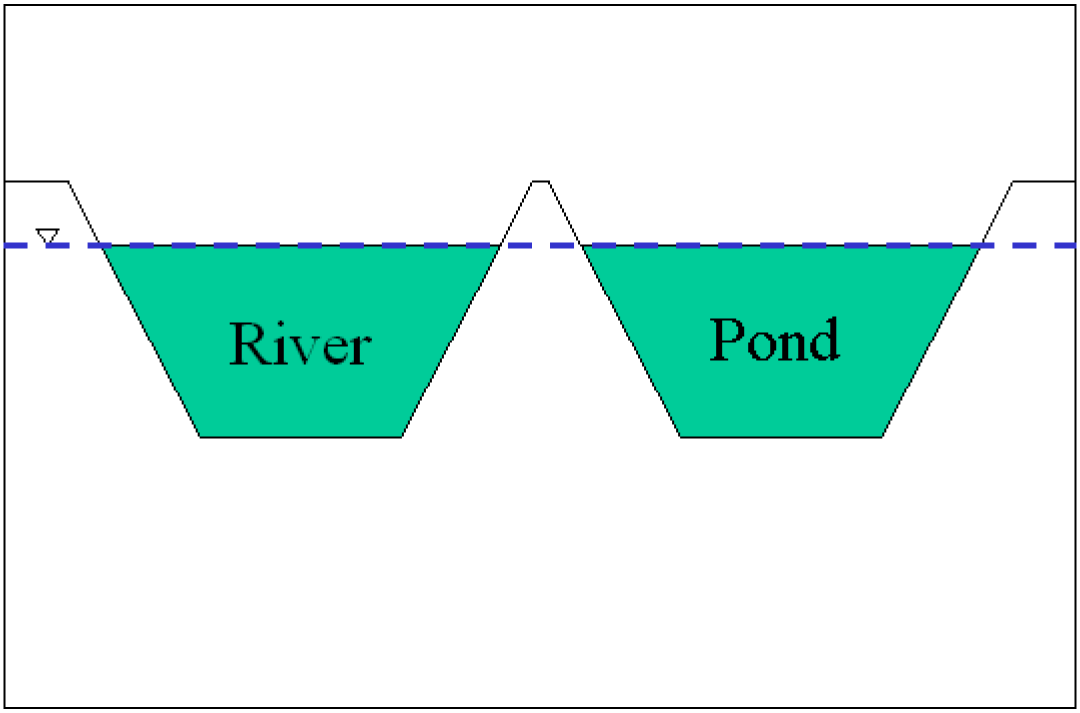

Figure 4. Jensen's Grove and the Snake River are hydraulically connected with the aquifer.

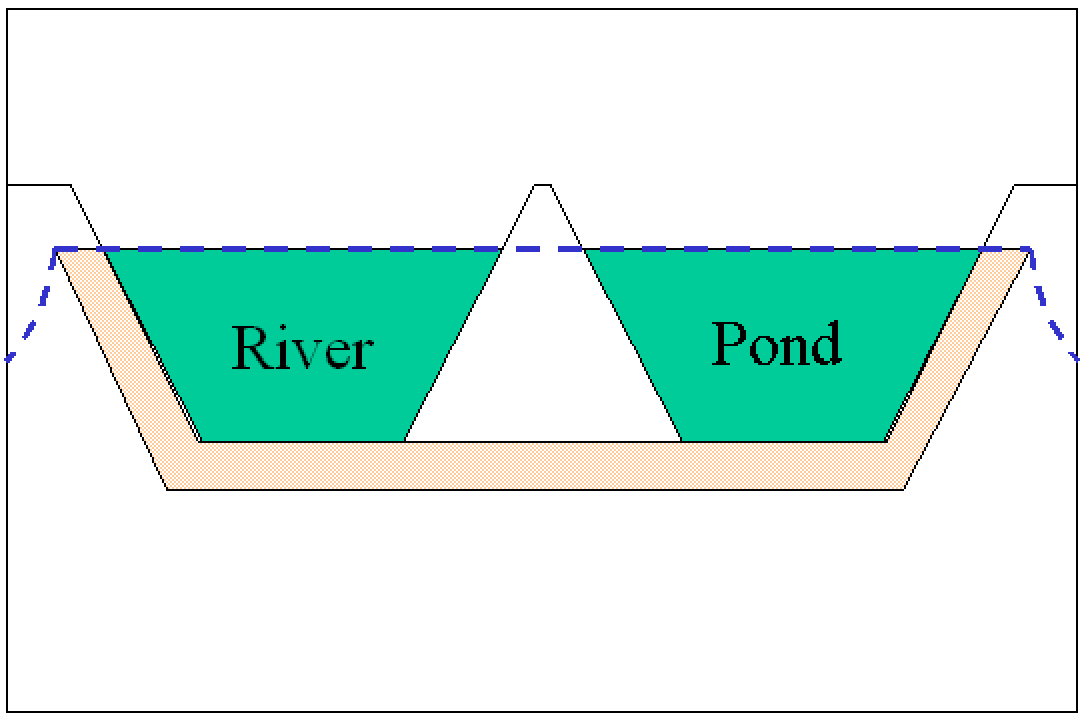

Figure 5. Jensen's Grove and the Snake River are hydraulically connected but insulated from the aquifer.

Figure 4 implies either a water table at approximately river-surface elevation, or extremely large losses from the Snake River and Jensen's Grove into the aquifer. The Snake River and Jensen's Grove water levels would always show a strong correlation in this scenario. Figure 5 shows a condition where Jensen's Grove and the Snake River could have modest seepage losses through less transmissive sediments and still have different water levels than those in the aquifer. Similar to the Figure 4 model, the Snake River and Jensen's Grove would have a strong correlation.

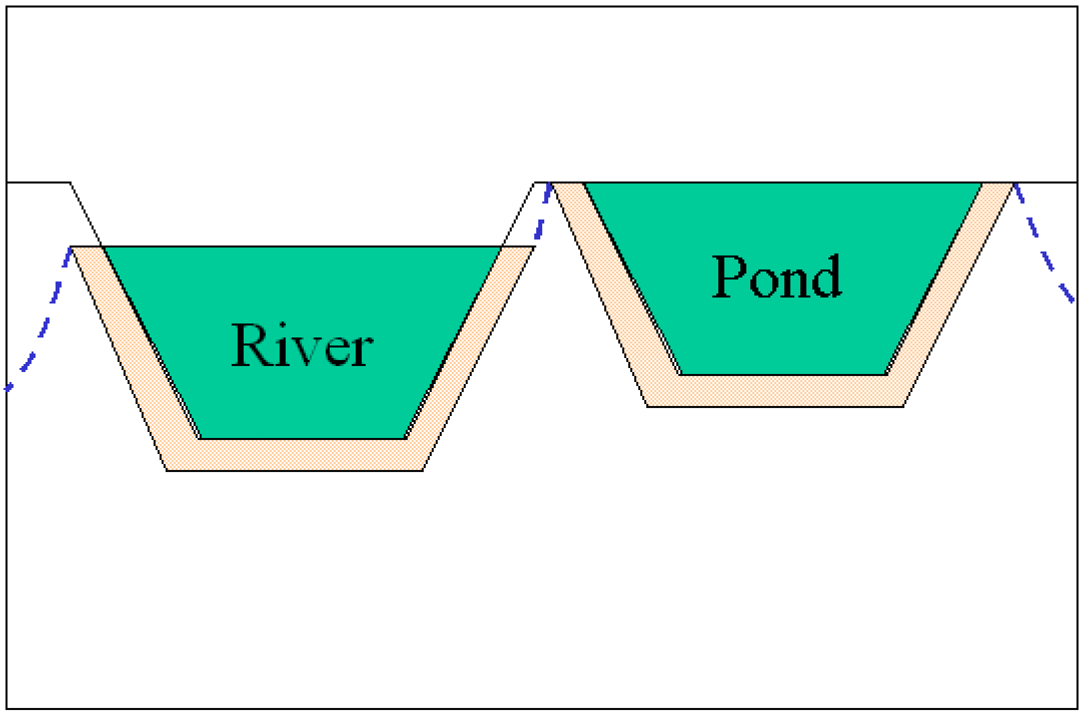

Figure 6. Conceptual model where Jensen's Grove and the Snake River are in communication with each other and the aquifer, but only through less-transmissive sediments.

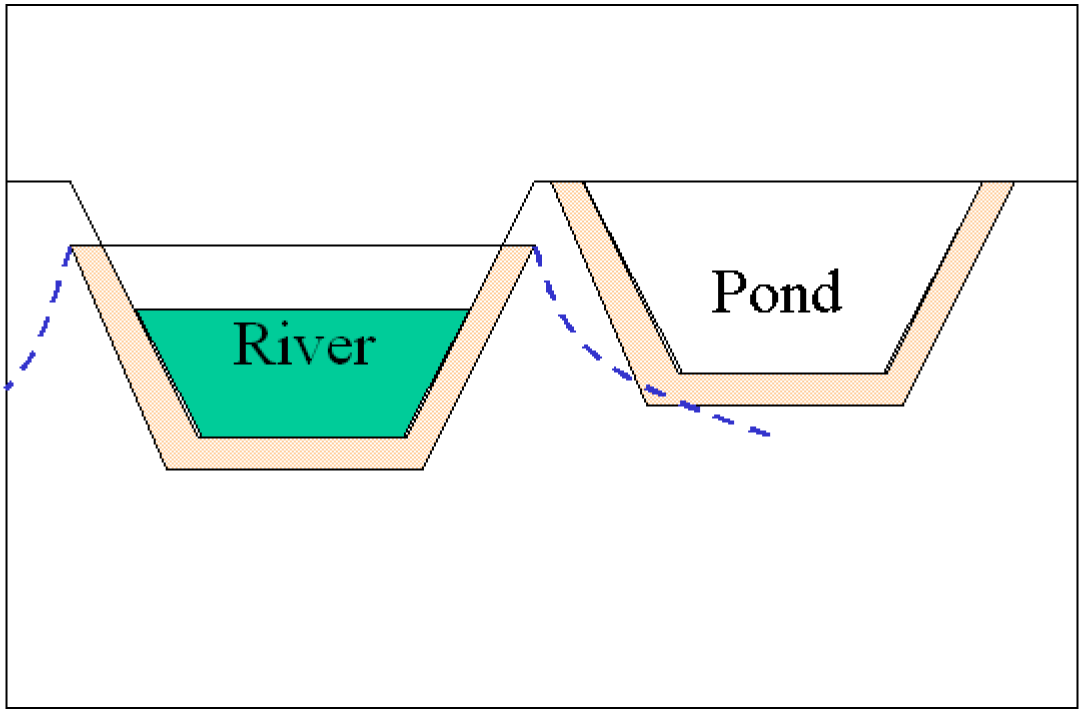

Figure 7. Conceptual illustration of the Figure 6 model with reduced Snake River levels and no inflow to Jensen's Grove.

Figure 6 and Figure 7 show a conceptual model where the Snake River and Jensen's Grove are both somewhat insulated from the aquifer by sediments, and also from one another. This model would allow modest seepage losses from the river and pond, allow stage in the Snake River and Jensen's Grove to be higher than in the local aquifer, and less correlation between the river and pond levels.

Figure 8 shows kriged aquifer water table elevations and the elevation of the Snake River. The elevation of the Snake River was obtained from 10 m Digital Elevation Models and the aquifer water table elevations were obtained by kriging data from the IDWR water level database and then sampling the kriged water table surfaces along the Snake River. These data show that the Snake River is above the inferred aquifer water table near Blackfoot for all the dates investigated.

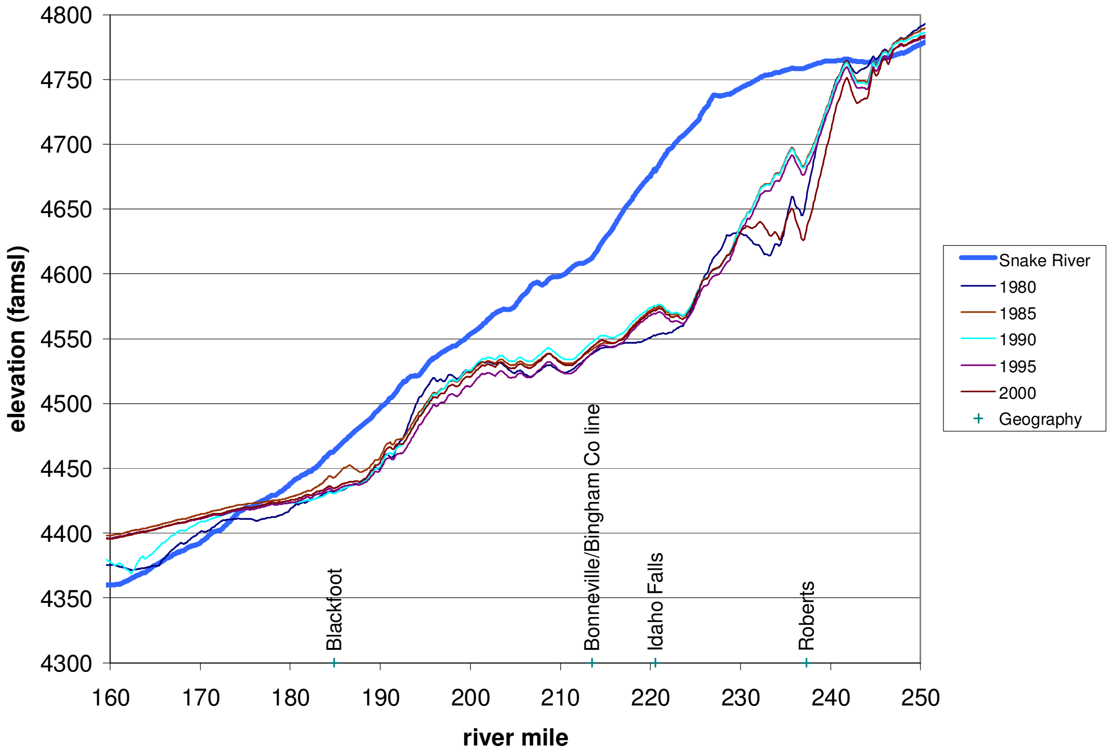

Figure 8. River profile showing Snake River elevation and kriged aquifer water levels.

The data presented in Figure 8 does not support the conceptual model presented in Figure 4. The profile presented in Figure 8 shows that the Snake River is always above the kriged water table at Blackfoot and this suggest that the conceptual models presented in either Figure 5 or 6 (and 7) are more likely.

Figures 9 through 11 illustrate cross-sections of the observed data from point River 1 to the Airport Well (see Figure 2).

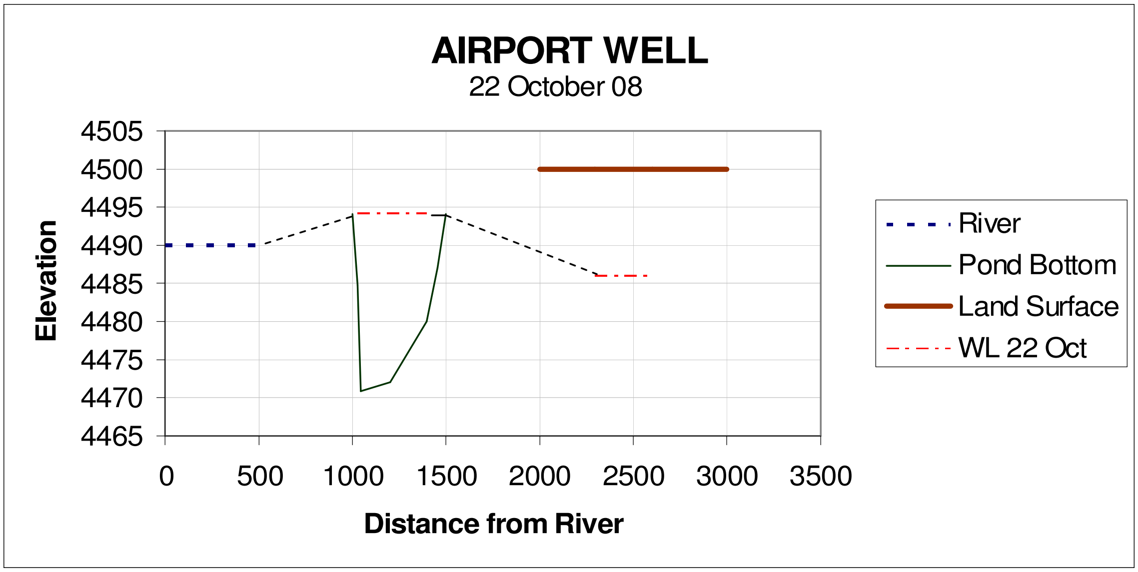

Figure 9. Airport Well cross section, October 22.

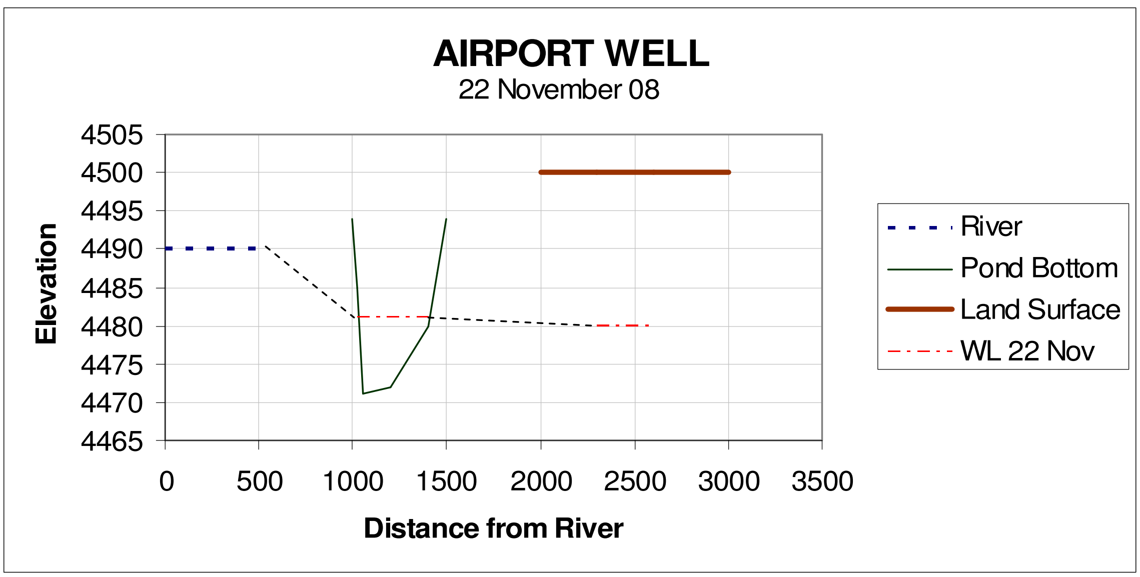

Figure 10. Airport Well cross section, November 22.

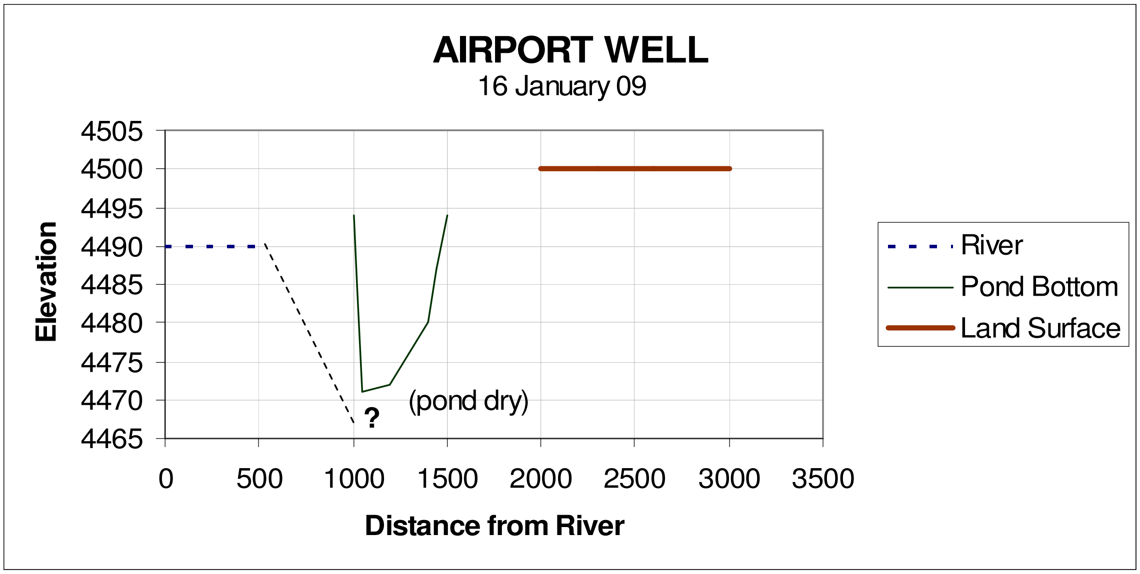

Figure 11. Airport Well cross section, January 16.

Figures 9 through 11 show little correlation between Jensen's Grove and the Snake River. In Figure 9 the level in the pond is higher than the Snake River, in Figure 10, after diversions to the pond stopped, the level in the pond is lower than the Snake River, and in Figure 11 the pond is dry while the water level in the Snake River is believed to have remained relatively constant.

The data presented in Figures 9 through 11 tend to support the Figure 6 (and 7) conceptual model. The Figure 6 conceptual model allows Jensen's Grove to go dry when diversions to the pond cease as the data presented in Figure 11 illustrate, and allow diversions to support pond levels higher than aquifer levels as the data presented in Figure 9 illustrate.

Discussion and Conclusions

The conceptual representation of the Snake River near Blackfoot in Eastern Snake Plain Aquifer Model v 1.1 (ESPAM1.1) includes a river that is hydraulically connected with the aquifer whenever aquifer levels are above a point 30 feet below the river elevation. Riverbed sediments have different properties than the surrounding aquifer. This is consistent with Figures 6, and 7. The model does not explicitly represent Jensen's Grove, pond but it can represent seepage from a feature like the pond by applying an aquifer inflow at the approximate location of the feature. The location of the recharge event is constrained by model cells, which are one mile square. The model cell best representing Jensen's Grove pond is centered approximately on the airport well. Figure 12 shows how ESPAM1.1 apportions impact from recharge at Jensen's Grove assuming steady state conditions (assuming recharge activities have been ongoing for a long time). ESPAM1.1 indicates that about 62% of the impact of recharge at Jensen's Grove is realized in the Shelley-near Blackfoot reach and about 32% of the impact is realized in the near Blackfoot-Neeley reach. This makes hydrologic sense given the conceptual model supported by the data gathered in this investigation and the proximity of the reaches to the recharge site. Figure 1 shows the locations of the Shelley-near Blackfoot and the near Blackfoot-Neeley reaches in relation to the city of Blackfoot.

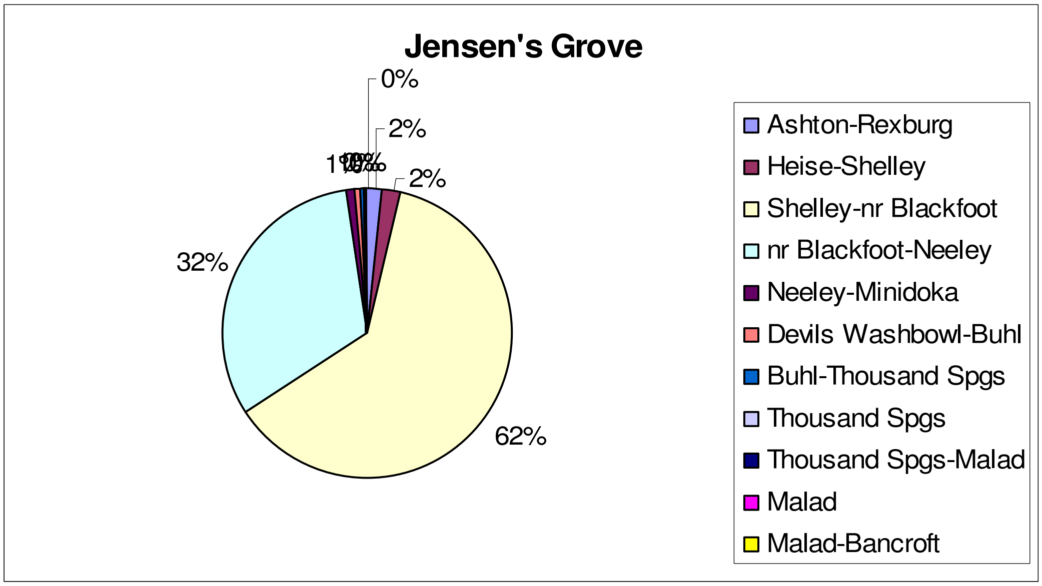

Figure 12. Model results showing where impact from recharge at Jensen's Grove would be realized.

Figures 13 and 14 show timing of the arrival of impact from recharge in Jensen's Grove in the Shelley - near Blackfoot and in the near Blackfoot - Neeley reaches assuming the recharge was introduced as a one time pulse. Figure 13 shows that the impact in the Shelley-near Blackfoot reach begins to accrue quickly. This makes good hydrologic sense because this river reach is adjacent to Jensen's Grove and Figure 8 indicates that the Snake River becomes hydraulically connected with the aquifer just down river from Blackfoot.

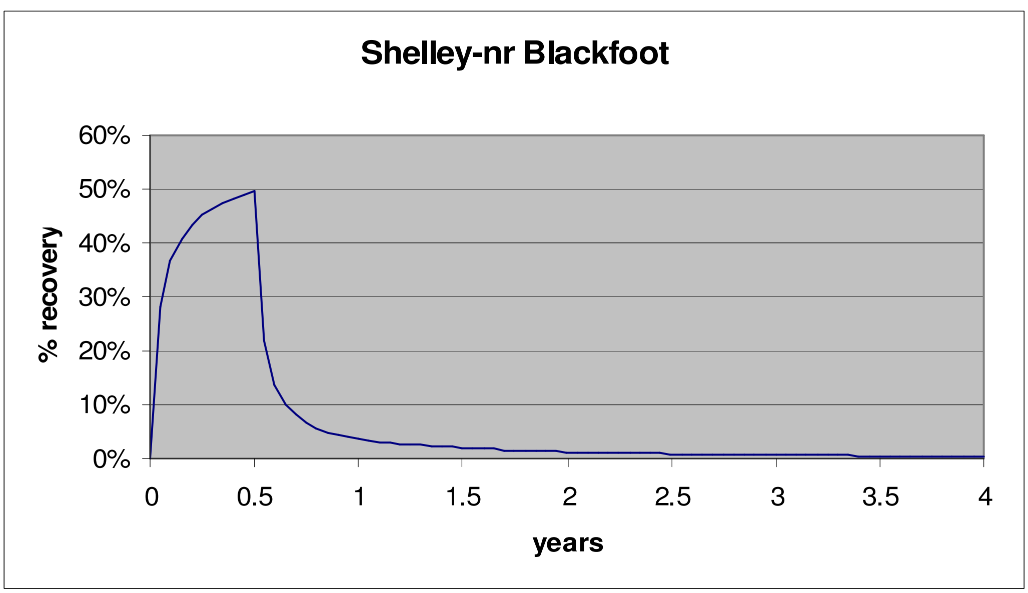

Figure 13. Transient response for the Shelley-near Blackfoot reach.

Figure 14 shows that the impact from recharge in the near Blackfoot-Neeley reach begins to accrue more gradually than in the Shelley-near Blackfoot reach. This also makes good hydrologic sense because this reach is farther downstream or southwest of Jensen's Grove. Figure 14 indicates that the benefits of recharge peak about 6 months after the onset of recharge at Jensen's Grove.

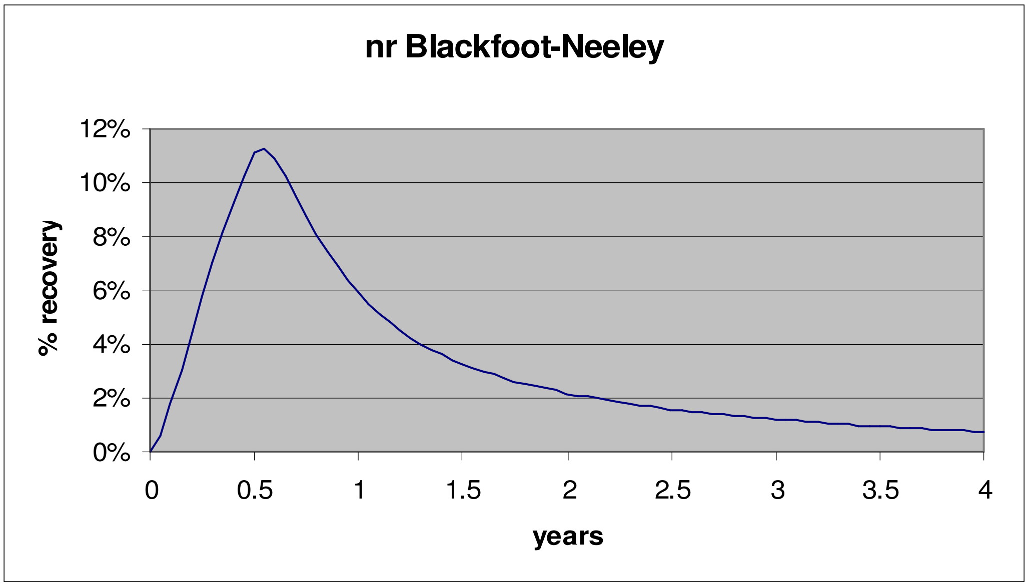

Figure 14. Transient response for the near Blackfoot-Neeley reach.

Recommendations

If either Figure 4 or Figure 5 were reasonable conceptual models, the management implication would be that water delivered to Jensen's Grove would quickly return to the Snake River. Water delivered to Jensen's Grove in the summertime would not impact downstream surface-water users, and water delivered for recharge would have little benefit at distant locations or later times. If Figures 6 and 7 more correctly represent the natural system, water delivered to Jensen's Grove would primarily affect the aquifer, raising water levels in the general area. While there would be some immediate effect on the river, much of the impact to the Snake River would be delayed and realized at locations distant from Jensen's Grove. The management implications would be that deliveries to Jensen's Grove reduce surface-water availability to downstream diverters in the short run and create delayed benefits later in time and at distant locations.

Since the available data support the conceptual model in Figures 6 and 7, Jensen's Grove can be considered a viable recharge site. This recommendation is from a technical perspective and does not address policy issues. Because Jensen's Grove is technically a viable recharge site we recommend: 1) maintaining the transducers in the Park and Airport wells, and 2) if a decision to use Jensens Grove for recharge is made, some means of monitoring pond inflow, outflow, and stage needs to be addressed.

The transducers in the Park and Airport wells belong to IDWR, and the Department wishes to install transducers in unused wells across the ESPA, so this recommendation appears achievable. If automated measurements are to be collected, monitoring pond inflow, outflow, and stage will not be trivial issues. The pond apparently receives inflow from three sources, a diversion directly from the Snake River and two inlets from local canals. It is likely all of the inlets to the pond will have to be modified to allow accurate automated measurement. The pond outflow will have to be modified to enable any measurement of surface discharge. Accurate measurements of inflow and outflow are necessary to allow calculation of recharge:

Recharge = inflow - outflow

Monitoring surface water can be problematic because the equipment can be damaged when the pond and ditches dry out and the formerly submerged transducers are subjected to weather and curious people and animals. Consideration should also be given to establishing a schedule for routinely checking the equipment, downloading the data and equipment repair and maintenance.

Acknowledgements

We thank the representatives of Blackfoot for their cooperation and allowing us access to the two observation wells. We also want to thank Stuart Van Greuningen from IDWR who collected the survey-grade GPS data.