

Technical Memorandum

Analysis of river-aquifer hydrology and timing for Dawson water right transfer

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Transfer application #74716 proposes to change a portion of water right 37-276F from a surface water diversion from the Big Wood River at the applicant's property to a groundwater diversion from a proposed new well to be located on the applicant's property within ~~200~~ feet of the Big Wood River east bank (see attached map). IDWR policy is that such transfers may be allowed if there is a direct and rapid response of the river gain or loss due to pumping at the proposed groundwater source. This circumstance might be expected if the well is very near to the river and if the hydraulic connection between the aquifer and the surface stream is very direct.

In the Dawson case, the perpendicular distance from the well to the water edge will be ~~200~~ feet or less. Static water level at this location is anticipated to be approximately 10 feet or less. Water level below ground in the existing domestic and irrigation well was measured on 11/26/07 to be 12.7 feet. At the time of drilling, the water level was reported as 9 feet below ground. This distance is approximate equal to the topographic relief between the land surface and river water surface. For analytical purposes, it was assumed that the average water level in the well is approximately coincident with the river elevation.

The aquifer at the well site is unconfined, and is comprised of unconsolidated alluvial deposits, chiefly sand, gravel, and boulders, underlain by granitic or limestone bedrock. The drilling record of the Dawson well, included with this report, does not indicate the presence of fine-grained materials, which could act as confining or semi-confining layers. The Dawson well record indicates that "soft brown sandstone" was encountered from 53 feet to the bottom of the hole at 61 feet, which may indicate the beginning of the bedrock. Most other wells in the immediate area are not drilled to the bedrock, but generally indicate that the alluvial aquifer is at least 60 feet deep. Two wells in Eagle Creek Meadows show bedrock at 70 feet and 55 feet, and one well in Chocolate Gulch subdivision indicates 63 feet. The saturated depth at the Dawson property was assumed to be 50 feet.

The new well will be fully cased and fully penetrating in the alluvium, i.e. either perforated or screened from the water table to bedrock. This is necessary so that water withdrawn will affect the piezometric head in the alluvium and therefore the river reach gain.

Water drawn from the well will cause a local drawdown in the aquifer, increasing in magnitude with time and decreasing with distance from the well. When this drawdown reaches the river boundary, it will cause an increase in gradient at the boundary, thereby reducing the reach gain (or increasing reach loss). In lieu of developing a full numerical groundwater model with a very short time step, analytical techniques were employed to estimate the timing and magnitude of this river influence. In this approach, the Theis equation is used with the method of images to estimate the gradient at the river

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boundary, and the method developed by Glover and Balmer (1954) is used to estimate the percentage of total pumping supplied by the river.

This simplification requires making several assumptions:

1. The Theis assumptions are reasonably valid.
2. The river acts as a constant-head boundary in the local vicinity of the well.
3. The method of superposition using image wells is valid to determine drawdown patterns in the presence of the constant-head boundary.
4. The influence of the well on the river discharge is indicated by the computed gradient of the water table at the river boundary.
5. The change in river-aquifer exchange compared to the no-pumping case is proportional to the gradient at the river boundary, i.e. Darcy's Law holds.

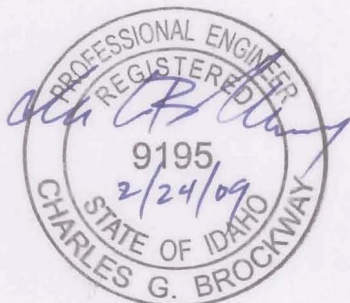
The analytical approach is illustrated by the attached conceptual diagram taken from Todd (1980) showing the pumping well, the river, and an image recharge well that results in a constant-head condition along the river. In this diagram, the discharging well is the Dawson well and x_1 is 200 feet. Initially, the water table is assumed to be horizontal in the x-direction with no gradient toward the well. As the well begins pumping, the water table remains coincident with the river level at $x=0$, but a gradient toward the Dawson well will be established at this point. This analysis applies only in the very local vicinity of the well, i.e. within 1000 feet or so. The main objective is to determine how quickly the river responds to well pumping. This information will allow IDWR to decide whether the diversion is essentially equivalent to a surface water diversion so that a direct surface-to-groundwater transfer can be made.

Hydraulic properties of the aquifer were assumed to be as follows:

- Hydraulic conductivity (K) = 104 ft/day – based on a controlled well test and analysis performed by Brockway Engineering on a large well drilled in 2006 approximately 1200 feet northwest of the proposed Dawson well.
- Storage coefficient (S) = 0.15 – typical of unconfined sand and gravel aquifers. Saturated depth = 50 feet – based on drilling record of the Dawson well.

A continuous pumping rate of 62.8 gpm (0.14 cfs) from the well was assumed, which is the diversion rate allowed by 37-276F. The time lag between commencement of pumping and the effect at the river is illustrated by the attached plot. A gradient at the river adjacent to the well begins after 2 hours of pumping and increases over time according to the pattern shown. Of the total water pumped, a portion will be supplied by the aquifer and a portion will be supplied by the river, until equilibrium is reached at which point all of the water is supplied by the river. This fraction Q_r / Q , where Q_r is the portion supplied by the river, is shown on the attached plot. 50% of the effect is seen after 10 hours of pumping, and 68% is seen after 24 hours.

This analysis indicates that criteria set forth by IDWR can be met: more than 50% of the river response will occur after 24 hours of pumping.



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