Attachment OP-9

Derivation of Transmissivity and Storativity of the HJ Horizon Unimpacted by the Lost Creek Fault

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Derivation of Transmissivity and Storativity of the HJ Horizon Unimpacted by the Lost Creek Fault

1.0 INTRODUCTION

The parameters necessary to provide an estimate of drawdown during the life of the Lost Creek Project include transmissivity, storativity, net extraction rate, and duration of operation. Transmissivity of the HJ Horizon has been determined from pumping tests, conducted on either side of the Lost Creek Fault. Because of the influence of the fault, the transmissivity determined from this pumping test is viewed as an 'effective" transmissivity.

2.0 IMAGE WELL THEORY

A value of transmissivity that is not influenced by the fault can be estimated using the principle of superposition and image well theory (Stallman, 1952). The principle of superposition simply states that the total effect resulting from pumping multiple wells simultaneously is equal to the sum of the individual effect caused by each of the wells acting separately. The principle of superposition is commonly used to evaluate well interference problems by summing the drawdown determined using the Theis equation for a homogeneous, isotropic, infinite extent aquifer. Image well theory is used to address hydraulic impacts of a bounded (non infinite extent) aquifer for either no flow or recharge boundaries (Domenico and Schwartz, 1990).

In the application of image well theory for a no flow barrier, an imaginary well is placed directly across the no flow boundary at an equal distance from the boundary as the pumping well. The image well is assigned a pumping rate equal to that of the real pumping well. Then the drawdown can be calculated at any point within the aquifer (on the side with the real well) by summing the impacts from both the real and image well, using a modification of the Theis equation:

$$s = s_p + s_i = (Q/(4\pi T))[W(u)_p + W(u)_t]$$

where:

s = the observed drawdown at any point;
s_p = drawdown resulting from pumping the real well;
s_i = drawdown resulting from pumping the image well;
Q = the pumping rate;
T = aquifer transmissivity;
$W(u)_p$ = well function for the real well;
$W(u)_t$ = well function for the image well;

and:

$(u)_p = r_p^2 S/4Tt$
$(u)_t = r_t^2 S/4Tt$

where:

r_p = the distance from the pumping well to the observation point;
r_i = the distance from the image well to the observation point; and
S = aquifer storativity.

3.0 APPLICATION TO THE LOST CREEK PROJECT

In the case of the Lost Creek Project, image well theory was applied using the drawdown resulting from the LC19M pump test. The pumping well LC19M is located 482 feet from the Lost Creek Fault, based on mapped data. An image well was assumed at a distance of 964 from the pumping well, on the other side of the Fault. The drawdowns at the end of the pump test at three wells were used to back calculate the transmissivity and storativity of the aquifer. Figure OP-A9-1 shows the location of the wells used to calculate transmissivity with the image well method.

The LC19M pump test was run for a period of 8,252 minutes at an average rate of 42.9 gpm. The wells and respective drawdown (at the end of the test) used to solve the Theis equation for transmissivity and drawdown were: LC19M (93.32 ft); HJMP111 (35.56 ft); and HJMP104 (36.44 ft). The distance from LC19M to HJMP-111 is 473 ft and from LC19M to HJMP104 is 637 ft. The distances from the image well to HJMP-111 and HJMP-104 are 1,043 and 847 feet, respectively.

A series of calculations were performed varying the transmissivity and storativity to find the best fit to the observed drawdown at the end of the test. Results of the effort indicate that a transmissivity of 144 ft^2/d and a storativity of 7E-05 provide a very good fit to the data with residuals (difference between the observed and calculated drawdown) of: 0.06 ft at LC19M; -1.04 ft at HJMP-111; and 1.00 ft at HJMP-104. Although this calculation does not account for the partial penetration effects of the pumping and observation wells or the minor leakage from overlying and underlying aquifers (as evidenced by the slight drawdown response in overlying and underlying observation wells during the test), it does provide a reasonable estimate of the aquifer properties within the vicinity of Mine Unit 1 (unaffected by the fault). Table OP-3b.1 shows the best fit drawdown calculations.

REFERENCES

Domenico, PA and FW Schwartz. 1990. Physical and Chemical Hydrogeology, John Wiley & Sons, New York.

Stallman, RW, 1952, Nonequilibrium Type Curves Modified for Two-Well Systems, U.S. Geological Survey, Groundwater Note 3.