APPENDIX C

Aquifer Hydraulic Testing Data

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MEMORANDUM

TO: Dan Wiitala

FROM: Tom Davis

DATE: September 27, 2005

SUBJECT: Analysis of Specific Capacity Testing Data from QAL031D

Data from the August 15, 2005 specific capacity testing of monitoring well QAL031D were analyzed to determine aquifer transmissivity and to calculate horizontal hydraulic conductivity for the saturated outwash beneath the discharge site. This work supplements aquifer testing at other locations that has been performed for the environmental baseline study using multiple-well pumping tests, specific capacity tests, and sieve analyses. Data from this site-specific testing were compared to data developed at other locations using similar methodologies and at locations where other methods were used.

The test was performed by North Jackson Company staff using standard methods for single-well pumping tests. The test was run at a constant pumping rate until an apparent equilibrium water level was achieved, as indicated by minimal change in water level with time during the test. Fletcher Driscoll & Associates provided the analysis of the drawdown and recovery data using the Cooper-Jacob method (Figures 1 and 2). Aquifer transmissivity was also calculated from the specific capacity data.

Analysis of the early data from the time-drawdown plot produces a transmissivity of 1,230 gpd/ft. Analysis of early data from the recovery plot produces a transmissivity of 1,888 gpd/ft. A specific capacity of 1.1 gpm/ft was calculated based on an average pumping rate of 2.9 gpm with a drawdown of 2.53 feet at about 2.5 minutes. An iterative approach using the Jacob equation was employed to calculate a transmissivity value using the specific capacity value and a storage coefficient of 0.05 (determined from a previous multiple-well pumping test). The transmissivity value calculated by this method was 1,500 gpd/ft. Thus, the aquifer transmissivity in the vicinity of this well ranges from about 1,200 to 1,900 gpd/ft, based on the standard Cooper-Jacob assumptions that include the condition that the well is 100-percent efficient.

The boring log indicates that a 13-foot thick zone of gravelly clay glacial till occurs at the bottom of the boring. It is unlikely that this zone was stressed by the testing. Thus this interval is not considered an active part of the tested zone and only 16 feet of the total 29 feet of saturated alluvium (saturated outwash and underlying glacial till) is assumed to contribute to the calculated transmissivity. Given the 16-foot thickness of the D-zone outwash deposits tested at this location, the hydraulic conductivities calculated from the pumping and recovery data range from 10 to 16 ft/day.

Interpretation of Results

Based on the time-drawdown response observed in the data during both the pumping and recovery periods, reduced well efficiency appears to result in transmissivity values that are likely somewhat less than true values for the aquifer. If QAL031D is about 50-percent efficient (a common value for small-diameter monitoring wells), then the specific capacity calculation described above understates the aquifer transmissivity and the true value is about 2 times the calculated value. On this basis, the transmissivity in the vicinity of QAL031D may be closer to 3,000 gpd/ft (2 times 1,500 gpd/ft) and the resulting calculated hydraulic conductivity is then about 25 ft/day.

The early time-drawdown data also appear to have been affected by delayed drainage. Time-drawdown data from tests of unconfined aquifers are nearly always affected by this phenomenon. As a test of this type progresses, the rate of drawdown increase begins to decline as water levels are affected by recharge from the draining water. This is reflected by a flattening slope of the plotted time-drawdown data. Transmissivities calculated from this flatter portion of the plot (later test data) result in values that are higher than values representing the actual aquifer characteristics.

Because the aquifer encountered in QAL031D is unconfined at this location and based on the data plots, it does indeed appear the time-drawdown data were affected by slow drainage. A nearly flat slope that occurs after about 4 minutes on the graph suggesting that some form of recharge is affecting the data (Figure 1). Based on the duration of the test (4 hours) and the large distance to surface water features (greater than 3,000 feet), the source of this recharge is most likely water slowly draining from overlying sediments. The transmissivity value calculated from this flatter portion of the plot, therefore, is not indicative of the true value for the aquifer in the area; the value is substantially higher than relative values calculated for similar materials at other locations using both specific capacity data and other aquifer testing methodologies.[1]

[1] A transmissivity value of 24,000 gpd/ft was calculated from the slope of the data at the end of the test. This value is unreasonably high. The hydraulic conductivity value determined from this transmissivity value is 200 ft/day—much greater than any conductivity value from the study area and not indicated by the character of the sediments found at QAL031D relative to the character of similar sediments at other locations.

Sieve analysis data from the screened zone of QAL031 were also used to estimate a hydraulic conductivity. The algorithm applied is the same one used to estimate hydraulic conductivity values at other monitoring locations for the baseline groundwater flow model as part of the baseline environmental study. This analysis produced a hydraulic conductivity of 26 ft/day—close to the value based on the 50-percent-efficiency assumption. A value of 25 or 26 ft/day compares reasonably well with the D-zone conductivities based on sieve analyses for nearby wells QAL008A (hydraulic conductivity of 49 ft/day) and QAL009D (hydraulic conductivity of 48 ft/day), where the sediments appear somewhat coarser.

The adjusted hydraulic conductivity (25 ft/day) from QAL031D is generally similar to values measured by other methods and at most other locations within the D zone (Figure 3). The majority of conductivities determined for locations within the D zone by the various methods (multiple-well pumping tests, specific capacity tests and sieve analyses) fall within the narrow range from 20 to 60 ft/day. The generally consistent values for sediments of similar character and from similar depositional environments indicate that the various methodologies provide the basis for a thorough understanding of the hydraulic conditions in the alluvium in the study area.

Figure 1. Specific Capacity Test -- QAL031D, Pumping

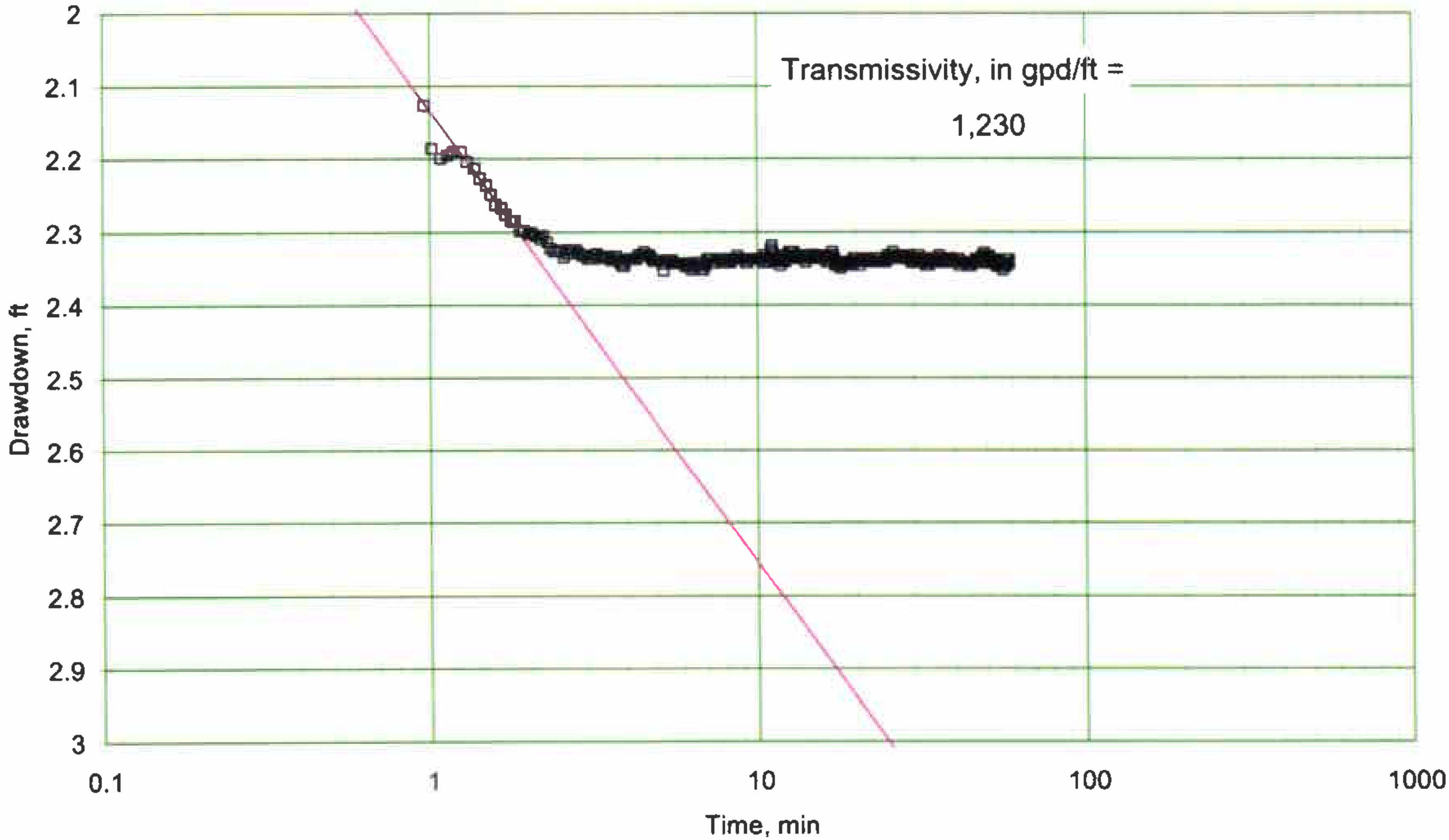

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Figure 2. Specific Capacity Test -- QAL031D, Recovery

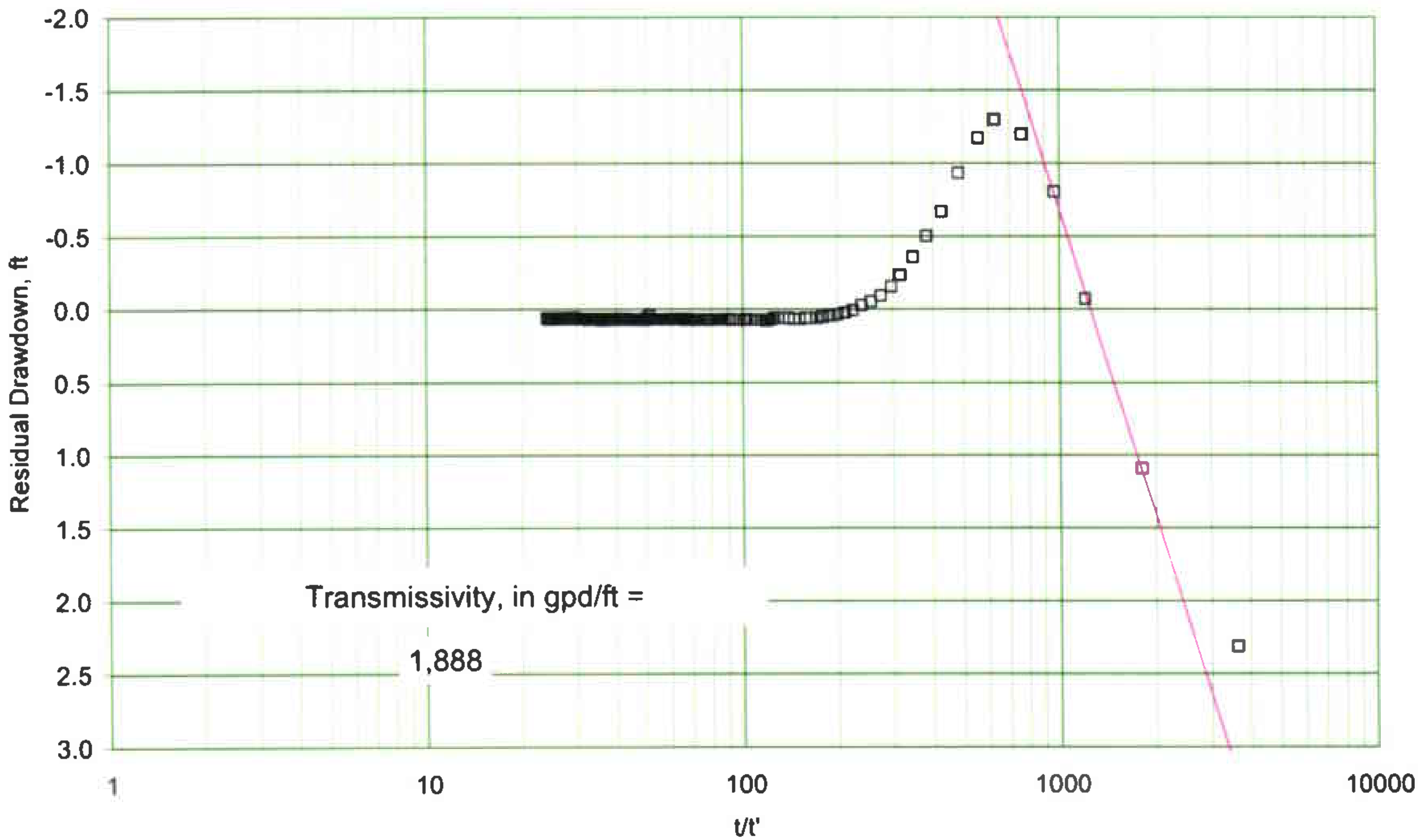

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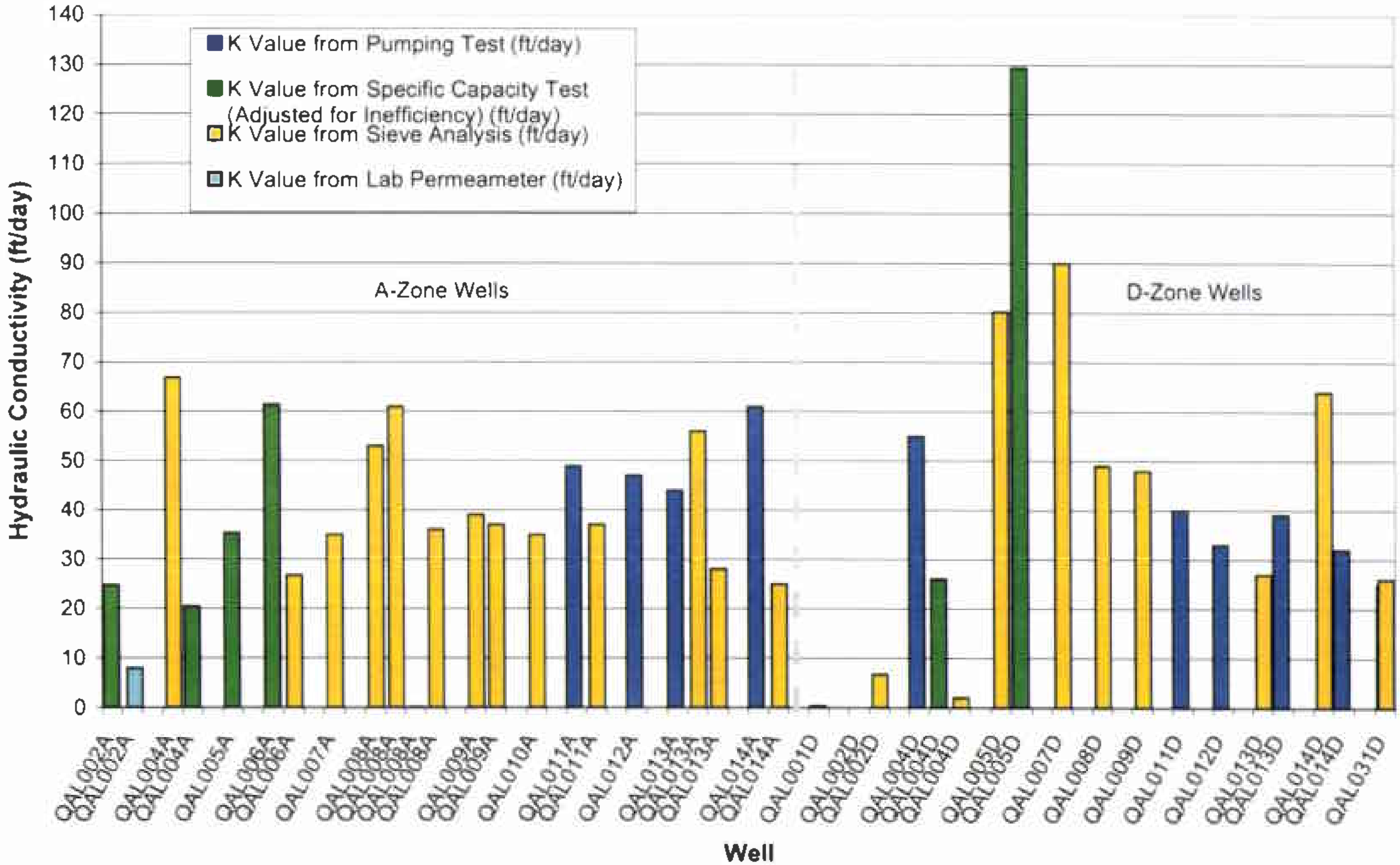
Figure 3. Hydraulic Conductivity Values Determined by Different Methods

(Values at each location may represent different depths)



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