Application of fractured aquifer characterization techniques in the development of a wellfield protection plan, Springdale, south central New Brunswick

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An integrated hydrogeological and borehole geophysical study was completed on the fractured sandstone and mudstone aquifer underlying the Springdale wellfield, located 18 km east of Sussex, New Brunswick. The objective was to characterize the bedrock fracture network responsible for the complex anisotropic conditions observed at the Springdale wellfield, and to determine the magnitude of the resulting drawdown around the primary and secondary production wells for purposes of developing a wellfield protection plan. Groundwater flow is primarily controlled by the distribution, and orientation of fractures dispersed throughout the aquifer.

Bedrock fractures were assessed by borehole logging methods within five vertical boreholes ranging from 36 to 91 m in depth. Detailed inspection of the borehole images revealed 179 high-angle fractures and 84 bedding parallel fracture planes. Statistical analysis of the orientation of high-angle fractures indicates that they can be grouped into three discrete sets with mean strikes of roughly 005°-185°, 063°-243°, and 144°-324°. Mean perpendicular spacing's between fractures of the same orientation were calculated to be 0.3 to 0.6 m, depending on the fracture set. Low-angle fractures associated with openings along bedding planes display a mean spacing of 1.2 m. Considering that high-angle fractures comprise 68 percent of the identified fracture network, and that 13 percent of these fractures possess apparent apertures greater than 10 mm, they are expected to be a dominant influence on groundwater flow. This contrasts with earlier studies of Carboniferous aquifers in the area that attributed most flow to sub-horizontal bedding plane fractures.

Anisotropic groundwater flow conditions were confirmed using a network of 8 monitoring wells during a 24-hour pump test with a variable pumping rate ranging from 4.9 to 7.7 L/sec (64 to 102 igpm). Drawdown of 1.31 m was recorded in the pumping well, with a resulting drawdown of 1.23 m recorded 592 m away in a southeast orientation, consistent with one of the high-angle fracture set orientations. Observation wells situated to the northeast and southwest show minimal drawdown during the test. This borehole-geophysical approach combined with other hydrogeological analysis lead to an improved understanding of the anisotropic conditions influencing the groundwater flow system, and has further aided the development of a hydrogeological model.

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