Using High Resolution Automated Instruments to Identify Karst Connectivity in a High Hazard Dam

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Foundation conditions at Rough River Dam have been monitored with open standpipe piezometers since 1974. Automated piezometers were first installed in 2013 along the downstream portion of the conduit on the right abutment in order to detect and monitor a suspected connection from under the stilling basin, through the karstic Beech Creek Limestone, to the soil/rock interface along the base of the embankment. The increased resolution of these instruments detected direct, immediate, and significant pressure variations within the clay embankment of the dam from changes in the water level of the stilling basin and tailwater. It was concluded that the karstic limestone under the embankment and conduit provided a direct stoping pathway from under the crest of the dam to the stilling basin. This finding resulted in the installation of 361-hole dual line grout curtain along the crest of the dam to intercept the pathway. Real time data retrieved during grouting from the automated piezometers and the instrumented packers allowed grout injection pressures and instrument responses to be correlated leading to a more effective grouting program and further confirmed the direct connection from the reservoir to the previously discovered pathway on the right abutment and identified a previously unknown karst network in the Haney Limestone on the left abutment connecting the upstream grout line to the toe. The automated instrumentation array was critical to the original identification of the interconnected karst network through enhanced monitoring. Conventional manual read instrumentation arrays limited the ability to detect and monitor karst foundation issues for the dam. The automated instrumentation array increased the effectiveness of grout monitoring and resulted in lower construction risk for the project during grouting. Overall, automated instrumentation resulted in a better understanding of the dam safety risk for the project by identifying multiple continuous flaws from upstream to downstream.