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THE DETROIT RIVER INTERNATIONAL CROSSING: IMPLEMENTING A PRECEDENT SETTING GEOPHYSICAL INVESTIGATION TO EVALUATE SUBSURFACE GEOLOGICAL STABILITY IN AN AREA OF HISTORICAL SOLUTION MINING

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Abstract

The development of any large scale infrastructure can present many geological and geotechnical challenges. During the development of the Detroit River International Crossing (DRIC) project, unique geological conditions were identified that created technical concern regarding the adequacy of the bedrock to support major foundation elements. The concerns were ultimately addressed through the implementation of a precedent setting multi-phase geophysical and rock mechanics based investigation.

The Detroit, Michigan area is underlain by numerous evaporate geological sequences (halite concentrated), which have been historically mined over the last 100+ years by room and pillar and solution mining methods. Historically, the majority of the salt was removed by solution mining, often with little to no documentation. Early solution mining was typically conducted through uncontrolled means with increased removal of salt from adjacent wells often creating large spans of unsupported rock. The individual cavities often coalesced with adjacent cavities to form large galleries. Eventually, as observed in 1954 and the early 1970s, in Windsor, Canada and Grosse Ile, MI, respectively, the massive unsupported spans collapsed to the surface to form large sinkholes. Additionally, over seven feet of settlement was reported historically in a brine field near Wyandotte, MI.

This paper serves to illustrate the challenges and steps taken to develop a program to investigate and clear an area to found the new DRIC crossing (suspension bridge) in an area known to have been historically solution mined. Challenges to implement this program include extensive rock drilling and a large scale geophysical investigation in a heavily urbanized area, adjacent to a major international shipping channel. The completed program included drilling 13 deep wells to facilitate the use and development of cross-well seismic imaging (cross-well) to determine brine cavity presence, size, and pertinent engineering characteristics. The cross-well also provided rock structure and geological conditions between boreholes for use in extensive rock mechanics modeling. This is one of the first applications of cross-well seismic imaging outside of the oilfield environment, with spacing between boreholes often exceeding greater than 450 meters (1,500 feet) and source frequencies to 2,000 Hz. The project also incorporated the use of borehole gravity techniques, vertical seismic profiling, and extensive wireline logging in an attempt to locate undocumented cavities. The paper will also discuss some of the factors involved with successful imaging of solution mining features, as observed during the program's successful implementation.

Key words: Bedded Salt Deposits, DRIC, Drilling, Geology, Geophysics, Michigan and Michigan Basin, Rock Mechanics, Seismic, Sinkholes, Solution Mining and Salt History, Subsidence, Well Logging