Engineering
UPDATE©

MEA MARINO ENGINEERING ASSOCIATES, INC. • Issue 35

HYDROLOGIC IMPACTS ON AN UNDERGROUND ABANDONED COAL MINE

There is a long history of coal mining in a town in the Midwest. In fact the coal mine, which was much of the focus of this investigation, was claimed to be at the forefront of mechanized mining coal. The mine operated from 1945 to 1959. This mine and the surrounding mines operated at depths that increased to the north with a dip in the coal from roughly less than 100 ft. to 285 ft. See Figure 1A. A report on the mine operations noted unusually dry conditions were present during the mining in this coal.

At shallower depths to the south, (due to the dip of the coal to the north), the coal seam was being stripped out in the area. This stripping operation was ongoing while the underground mining was taking place. See Figure 1B. The stripped area was in the lowlands, therefore significant amounts of runoff drained into the mined pit. This could be clearly observed on the historic photos of the area.

In 1959, the underground mining of coal was terminated, however strip mining continued to the north at increasing coal depths. By the late 70's to early 80's, the stripping intersected with the main mining complex in the area resulting in the runoff. This runoff would collect in the pit, and proceed to drain into the old works down dip. Concurrently, during this period of time there had been a number of subsidence events resulting in significant damage. As a result, concern grew throughout the area, resulting in federal aid to address the subsidence problem. It is suspected that this rash of subsidence was the result of pooling/flooding on the mine floor areas susceptible to severe moisture deterioration.

From examining air photos, the stripping operation continued until about 1998. By 2004, except for a few pits at the final highwall, the most stripped areas were reclaimed. By this time the remaining pits adjacent to the final stripped highwall had filled up with water due to runoff collecting in the lowlands and a shallow groundwater table. See Figure 1D. This occurrence also indicated that the old works to the north had also reached essentially hydrostatic conditions which approximated the shallow groundwater table. By this time, areas which had not failed from moisture induced deterioration had weakened over the long term, but were now supporting the lighter buoyant weight of the overburden given the hydrostatic condition. In mine areas of similar elevation and

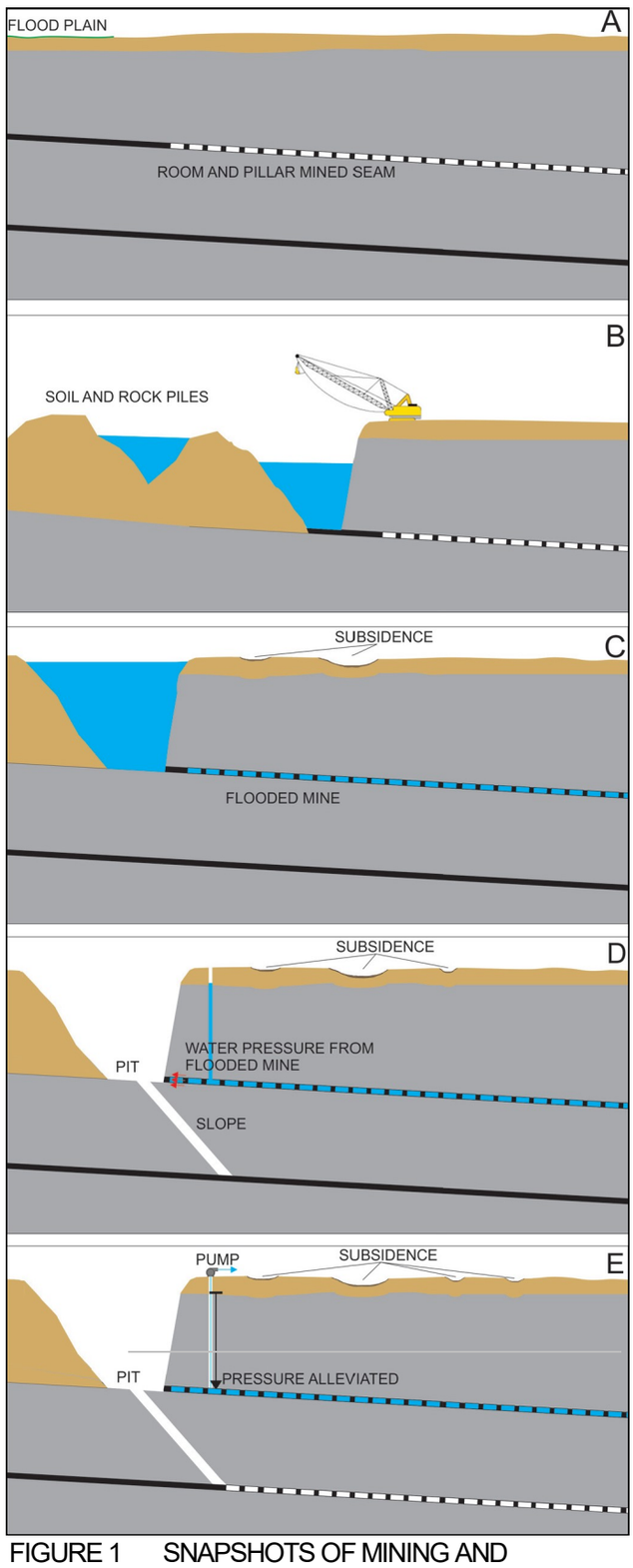

FIGURE 1 SNAPSHOTS OF MINING AND HYDROLOGICAL CONDITIONS OVER TIME

just below that at the pumping location, the overburden loads are estimated to be about 40% lower than before complete flooding.

In or around 2004, it was decided that the underlying coal seam would be mined by driving a slope through one of the pits left next to the final highwall. In order to access this unmined coal through the pit, it had to be pumped out. This would, however, leave water pressure in the adjacent old works against the highwall with the threat of a hydrostatic blowout and sudden inundation of the underlying active workings. See Figure 1D. Therefore, in order to relieve this water pressure, 3 dewatering wells were installed in the old work near the highwall and the water level in the mine was dropped to about the roof line. In order to accomplish this task, up to 5.5 million gallons of water per day needed to be pumped out of these abandoned workings and the surrounding area over an extended period of time.

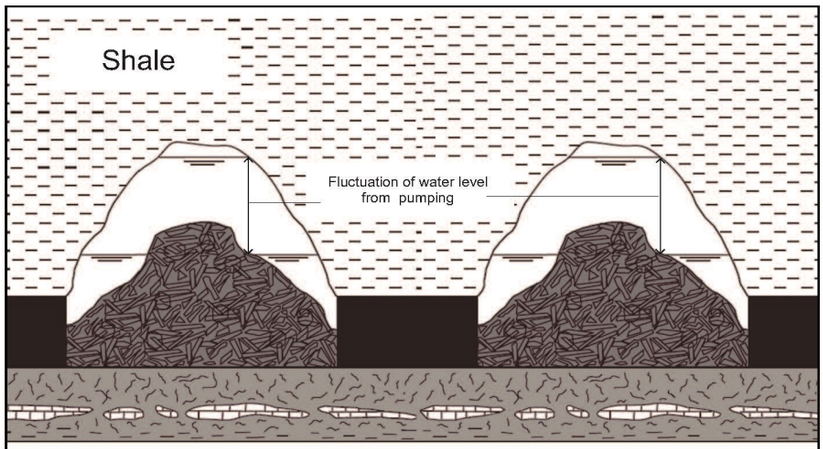

FIGURE 2 ROOF FAILURE ABOVE ROOM

As a result of the dewatering, the water level was dropped as much as about 140 ft. over extended periods of time, but would vary depending upon the pumping effort. In other words, in addition to putting the full weight of the overburden back on the mine structure that had been subjected to long term moisture deterioration, the dewatering resulted in oscillating water levels causing cyclic slaking and roof cave conditions (see Figure 2). In effect, this roof deterioration would result in heightened pillars with reduced capacity. Given the now softened floors, reduced pillar capacity, and significant increase in overburden load from dewatering, a substantial increase in surface subsidence was observed. See Figure 1E.

SUMMARY

This UPDATE article discusses a project investigation of the effects that mine flooding and subsequent dewatering have on surface subsidence. Due to the non-durable rock conditions associated with mine structure, these hydrologic impacts were found to cause a significant number of mine collapses and subsequent subsidence events.

Other Engineering UPDATES of Interest:

UPDATE 21: Mine Subsidence Damage During Construction of Medical Center

UPDATE 14: Establishing Mine Subsidence Risk

UPDATE 24: Anatomy of Mine Grouting Voids

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 24 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact Dr. Marino at the address listed below.

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