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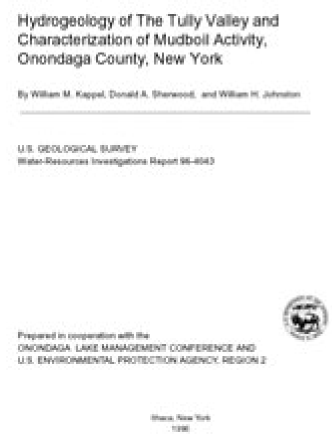
Hydrogeology of the Tully Valley and Characterization of Mudboil Activity, Onondaga County, New York


Hydrogeology of The Tully Valley and Characterization of Mudboil Activity, Onondaga County, New York

By William M. Kappel, Donald A. Sherwood, and William H. Johnston

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Prepared in cooperation with the
ONONDAGA LAKE MANAGEMENT CONFERENCE AND
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 2

Ithaca, New York

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ABSTRACT

Mudboil activity in the Tully Valley, in central New York, is causing turbidity in nearby Onondaga Creek, where it has caused a bridge to collapse; it also has threatened or damaged other structures and has caused extensive land subsidence. Mudboil activity was intermittent from its first reported appearance in the 1890.s until the 1970.s, when the rates of mudboil discharge and land subsidence began to increase. Historically, the water discharged from mudboils was reported as fresh, but chemical analyses in the late 1970.s indicated an increase in specific conductance and chloride concentration.

Mudboil discharge is driven by artesian pressure in unconsolidated sediments that are confined by a 60-foot layer of silt and red clay. This process, once begun, has been self-propagating. Artesian pressures are about 20 feet above land surface over most of the valley floor but exceed 30 feet above land surface along Onondaga Creek where Rattlesnake Gulf and Rainbow Creek enter the Tully Valley. The source of artesian pressure is recharge from the Tully (Valley Heads) Moraine at the south end of the valley, and the alluvial fans of Rattlesnake Gulf and Rainbow Creek. The mudboils are found within a 300-foot-wide by 1,500-foot-long corridor along Onondaga Creek just upstream from the two alluvial fans, and in a 5-acre subsided area just west of that corridor.

Remediation efforts have entailed (1) diversion of flow from the tributary that feeds the subsided area, (2) installation of depressurizing wells at several locations, and (3) construction of a dam and settling impoundment to detain mudboil sediment that would normally discharge to Onondaga Creek. These efforts have been partly successful, but further work is needed to slow the mudboil activity, which is expected to persist in both areas. Mudboil activity is normally greatest during the early spring and late fall, when artesian pressures increase in response to seasonal ground-water recharge.

Suspended-sediment concentrations at the out-flow of the subsidence area ranged from 31,210 mg/L (milligrams per liter) in October 1991 to 17 mg/L after remediation efforts in the summer of 1993. Yearly average suspended-sediment loads to Onondaga Creek from the subsidence area for water years 1992, 1993, 1994, and 1995 were 29.8, 9.75, 1.41, and 1.80 tons per day, respectively. Sediment

discharged from the mudboils initially was 30 to 60 percent clay and 80 to 100 percent silt-sized or smaller sediment, and the sand fraction never exceeded 20 percent. After the remediation projects, 50 to 80 percent was clay, and nearly all sediment was silt size or smaller.

Analyses of water from upstream and downstream of the subsidence area, as well as from mudboil vents within that area, indicate that the source of water for some mudboils is a confined freshwater aquifer, whereas for others it is an underlying, brackish-water aquifer. Water from the freshwater aquifer has specific conductance values ranging from about 400 ?S/cm (microsiemens per centimeter at 25 o Celsius) to almost 900 ?S/cm, dissolved chloride concentrations range from 37 to 430 mg/L, and dissolved-solids concentrations range from 215 to 463 mg/L. Specific conductance of water from the brackish-water aquifer ranges from 17,000 to 28,000 ?S/cm, chloride concentrations range from 2,000 to 7,100 mg/L, and dissolved-solids concentrations range from 4,200 to 12,800 mg/L.

The largest landslide in New York State in the last 75 years occurred at the foot of Bare Mountain, 1 mile downstream from the mudboil area, in April 1993 and was the fourth in a series of slides that have occurred at the base of this hill. Slope instability was reported as early as May 1990. After the slide, intermittent mudboil-like activity was observed at several springs within the backscarp of the slide; water from these springs ranged from fresh to brackish. The chemical similarity between water from some springs in the backscarp area and water in the lower (brackish) aquifer beneath the mudboil area may indicate a hydraulic connection between this aquifer and the surficial deposits.

Hydrologic changes in the valley during the last 100 years have been attributed to salt-solution mining in the upstream (southern) end of the valley. The removal of nearly 150 feet of salt from four evaporite beds in the Syracuse Shale of the Salina Group has caused the collapse of bedrock and unconsolidated deposits in and near the brine field, 3 miles south of the mudboil area. These collapses have created a hydraulic connection among bedding plane aquifers in the bedrock and increased the hydraulic connection with unconsolidated aquifers. The ground-water flow system after brine field closure in 1988 may have reached a new semiequilibrium, but mudboil activity will likely continue because artesian pressures remain. Whether mudboils were present before salt solution-mining began is unknown.

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